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All-Concrete Tile-and-Joist Floor Built with New Filler

New Concrete Floor Unit Has Top Rib for Nailing Sleepers—Simplifies Plastering and Placing of Floor Finish—Other Advantages Listed

IN and around Nashville, Tenn., extensive use is being made of a new type of filler unit for forming joists in what is commonly called tile-and-joist reinforced concrete floor construction. Design of these units is a distinct departure from the type of fillers commonly used in floors of this kind. The units are light in weight, being made of cinder concrete, and are manufactured with a rib or lug, as it is sometimes called, on top. (See Figure 1.) This rib, which runs the length of the unit, is 2 in. high, 4 in. wide and 8 in. long.

Rib Serves Double Purpose

The rib serves a dual purpose. It is a guide for screeds or strike-off boards when the concrete is being placed and, after the slab has hardened, the rib becomes a nailing base for sleepers when the floor is to be surfaced with wood flooring.

Size and Weight of Units

Each of these cinder concrete filler units is a two-core tile 16 in. wide and 8 in. long, as the unit rests in the floor forms, and can be obtained in a height of 6, 8 or 10 in., depending upon what joist depth is required in the floor design. Being available in any one of these three sizes, these units may be used in reinforced concrete floors designed for almost any type of loading, from the fairly simple residence floor to the heavier construction required in larger buildings. These units, which are made with walls 1 in. thick, are light in weight. One unit 6 in. high weighs 18 lb.; the 8-in. 20 lb., and the 10-in. size, 22 lb.

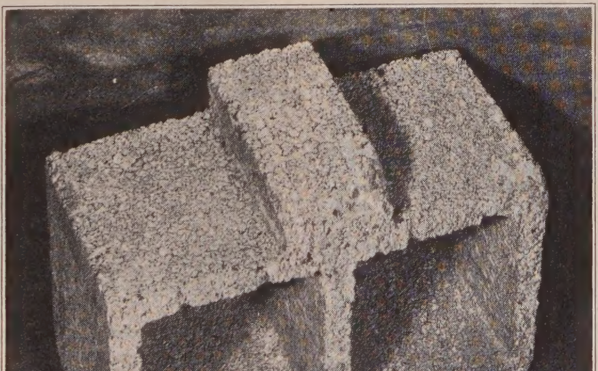


Figure 1. Cinder concrete floor filler 16 in. wide, 8 in. long and 10 in. high. Note rib on top, to which sleepers are nailed.

Charles William Akers, manager of the Nashville Breeko Block and Tile Co., the plant which is making these units available in the Nashville building area, advises that they are being very well received in his territory. He also lists the following advantages of tile-and-joist construction in which these fillers are used:

(1) Fireproof floor construction, all concrete.
(2) Soundproof, high coefficient of sound insulation.
(3) Flat ceiling eliminates scratch coat of plaster.
(4) No metal lath required on floor or ceiling.
(5) Flat ceilings stop sound passage over tops of partitions.
(6) Floor height saves 2 in. in each story, on account of elimination of furred ceiling.
(7) Light weight saves in handling and structural design.
(8) Although seldom necessary, special end tile can be furnished for long spans, where additional shear is needed in end of joists.
(9) Strength, ample for safety factor.
(10) Speed of erection, using simple skeleton centering forms and light-weight tile fillers.

Notches Space Temperature Steel

The rib on each of these tile has a beveled end which, when adjacent to another tile in the row, forms a "V" that provides proper spacing for the transverse temperature steel required in the concrete slab. Figure 2 shows the temperature steel in place in the "V" notches.

In ordinary construction, the ends of the rows of tile are closed with pieces of corrugated cardboard, cut to size and furnished by the manufacturer, which are nailed into the cinder concrete. These are placed after all form work is completed, with tile fillers, joist reinforcement, conduits and temperature bars in place, and just before the concrete is placed. Ordinarily, two nails will hold the closers in position.

Contractor Gains From Economy

On one contract in Nashville, where these units were used in floor construction for the Buena Vista Junior High School building, work of placing tile fillers was greatly simplified. According to S. R. Underwood, general construction superintendent for J. B. Regen and Son, the general contractors handling this contract, the fillers were much more easily worked with than any he had ever used. This construction superintendent also reported that considerable economy was made possible through the use of these units.

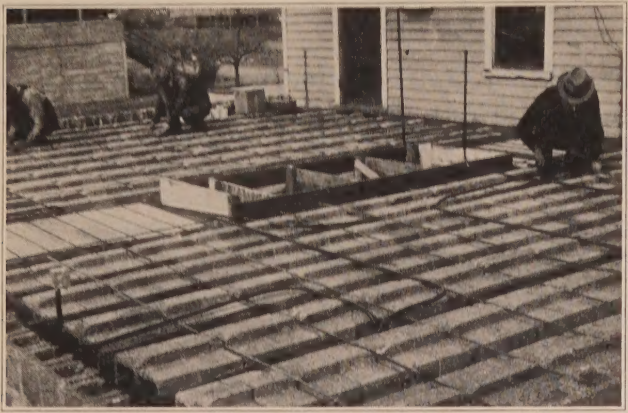


Figure 2. Installing temperature steel and conduits. Steel is placed in notches in rib

Units Made With Stripper Machine

Of interest to concrete products manufacturers is the fact that these units are made on a stripper machine, the daily production of any size being practically equivalent to the number of 8 by 8 by 16-in. building block which can be made with an Anchor Jr. stripper in one day.

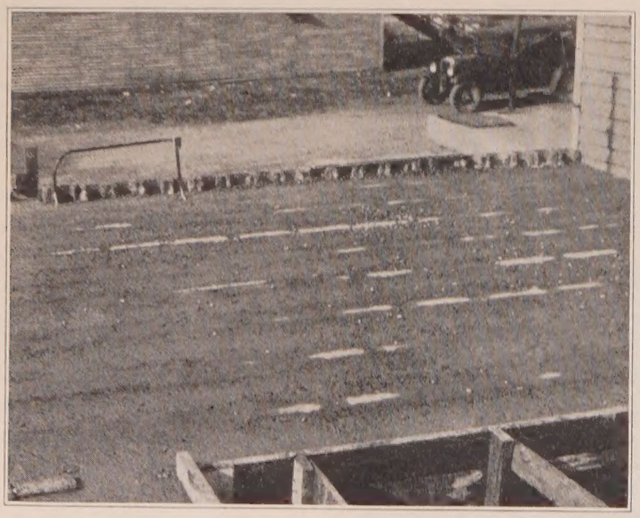


Figure 3. Concrete in place. Note exposed ribs of tile to which sleepers are nailed

The Nashville Breeko Block and Tile Co. is recommending this floor system for use in fireproof hotels, apartments, hospitals, dormitories, schools, homes and other buildings that require wood flooring and flat ceilings. The Nashville company is one of the affiliated plants of the National Building Units Corp., of Philadelphia.

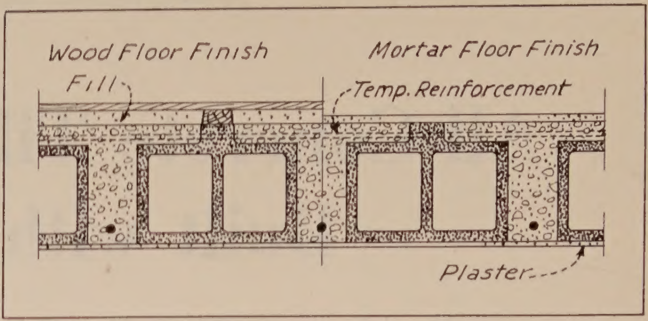
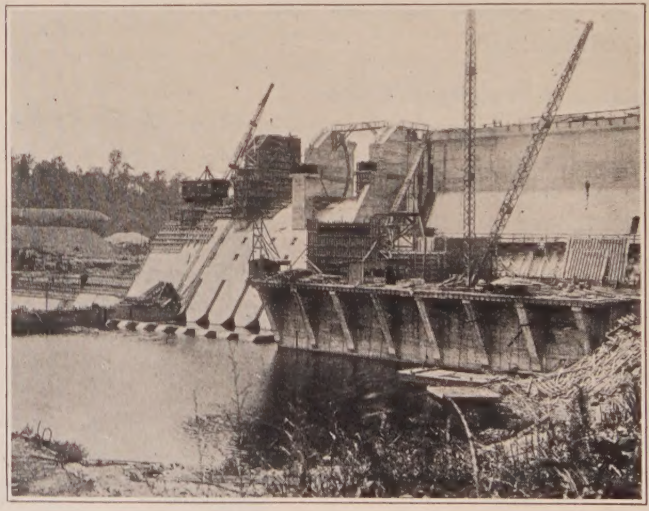


Figure 4. Cross-section of floor construction

Heavy Concreting Equipment Employed in Arkansas Dam Construction

HEAVY concreting equipment is being utilized in the construction of the Carpenter dam near Hot Springs, Ark., for the Arkansas Power & Light Co.

The equipment used for conveying concrete, handling aggregates and forms, and similar work, consists of two 8-ton capacity steel whirleys electrically driven, self-propelling on the track, with 80-foot booms for handling concrete and excavating material; there is also one steel guy derrick, 100-foot boom, with a capacity of 20 tons, also with an electric drive; two wood, stiff-leg, derricks, air operated, with a capacity of ten tons. There are two gasoline driven cranes, one caterpillar for handling excavation and concrete forms. Two gasoline driven caterpillars, one cubic yard capacity each, form the backbone for excavating equipment; five gasoline and four steam locomotives, together with forty dump cars, comprise the transporting array for the narrow gauge railroad and the yard and plant railroad at the job.



Heavy concreting equipment on dam construction

Cement Factors in Highway Concrete Have Wide Range of Values

Thirty States Specify 1.50 Bbl. or More Per Cubic Yard of Concrete—Consider High Factor Good Insurance—Texas Making Extensive Experiments

IN the matter of minimum cement content, the practice of our state highway departments may be said to be in a state of flux, a fact that is well indicated in letters written to CONCRETE by highway engineers of 42 states and the District of Columbia.

While 30 states are specifying minimum cement contents ranging from 1.50 to 1.75 bbl. to the cu. yd. of concrete, others are experimenting with values considerably below 1.50 bbl.

Tabulation of Minimum Cement Content

The following tabulation gives the practice in the various states in condensed form. Where the figure alone is given, without comment, it is understood that the value given applies to paving concrete. All figures are given in barrels, for convenience in making comparisons, though many states specify cement content in terms of sacks. The minimum values established by the various states follow:

Alabama. 1.55 bbl. per cu. yd. of concrete.

Arizona. None established.

Arkansas. 1.35 bbl.

California. 1.50 bbl. for Class A paving concrete, with tolerance of 2½ per cent.

Colorado. Determined indirectly, from cement-aggregate-water weights set forth in specifications.

Delaware. Not directly. Arbitrary proportions specified, with aggregates proportioned by weight.

District of Columbia. 1.60 bbl.

Florida. 1.50 and 1.55 bbl. for paving concrete; 1.25 to 1.85 for various grades of concrete in bridges.

Georgia. 1.50 bbl. generally, but may vary.

Idaho. 1.50 bbl.

Illinois. Not directly. Depends in part on mortar voids in aggregate.

Indiana. 1.70 bbl.

Kansas. 1.45 bbl.

Kentucky. 1.50 bbl.

Maine. 1.55 bbl.

Maryland. 1.50 bbl.

Massachusetts. 1.60 bbl.

Michigan. 1.50 bbl.

Minnesota. None established.

Mississippi. 1.50 bbl. where 2-in. stone or gravel is used.

Missouri. 1.40 bbl.

Montana. Specify 1:2:3 proportions, by weight, for one-course pavements.

Nebraska. 1.75 bbl. when sand-gravel aggregate is used; 1.625 bbl. when two sizes of coarse aggregate are specified. Changes in requirements being considered.

Nevada. 1.575 bbl. for Class A construction.

New Hampshire. 1.65 bbl.

New Jersey. Averages about 1.65 bbl., but is dependent on, and varies with, voids in aggregates.

New Mexico. 1.70 bbl. for paving concrete; 1.575 for Class A and 1.30 for Class B concrete in structures.

New York. Not directly. Depends on voids in aggregates and specific gravity of aggregates.

North Carolina. 1.42 and 1.32 bbl. for two grades of stone concrete; 1.30 and 1.20 bbl. for two corresponding grades of gravel aggregate.

North Dakota. 1.50 bbl.

Ohio. Ranges from 1.725 to 1.15 bbl. for various grades of concrete.

Oregon. 1.54 bbl.

Pennsylvania. 1.50 bbl. for concrete in wearing surface, and 1.40 in base course; 1.40 bbl. for Class A and 1.10 for Class B concrete in structures.

Rhode Island. 1.60 bbl.

Tennessee. 1.40 bbl.

Texas. 1.125 bbl. maximum, but are experimenting with factors of 1.00 bbl. and less.

Utah. 1.70 bbl. for paving concrete; 1.575 bbl. for bridge concrete.

Vermont. 1.50 bbl.

Virginia. 1.30 bbl. tentatively.

Letters received from the highway engineering departments of forty-two states and the District of Columbia, in reply to letters addressed to them by "Concrete," have provided a large fund of information on present-day highway engineering practices.

Digests of these letters are appearing in successive issues of "Concrete," each issue dealing with a specific problem. The first article, published last month, discussed and illustrated the subjects of resurfacing and widening. The present installment covers the question of minimum cement content, while next month's issue will tell of the extent to which better highway concrete is being made through the use of two or more sizes of coarse aggregate.

Highway engineers will find these digests of great value as indicators of trends in paving progress.—The Editors.

Washington. 1.67 bbl.

West Virginia. 1.55 bbl.

Wisconsin. 1.25 bbl. for pavements; 1.50 bbl. for structures, but with some variation, depending on the aggregates used.

Wyoming. 1.60 bbl.

Majority Maintain High Cement Factor

As previously mentioned, 30 out of the 43 states reporting maintain minimum cement contents at 1.50 bbl. or higher. Of the remaining 13 reporting states, 5 do their proportioning in such a way that cement factors cannot be definitely stated, 4 maintain a minimum factor of 1.40 or more, while 4 important states—Arkansas, Texas, Virginia and Wisconsin—seem to be definitely committed to cement contents of less than 1.40 bbl. to the cu. yd. of concrete.

Advocates of High Cement Factor

The argument for the advocates of high cement factors is well stated by William J. Titus, chief engineer of the Indiana State Highway Commission, who writes: "Our specifications have for a number of years required a minimum cement content of 1.70 bbl. per cu. yd. of finished concrete in pavements. This is somewhat higher than the minimum required by a number of other states; but the small additional cost involved in the slightly higher cement content is probably an inexpensive form of insurance for good concrete. It has been our feeling that the strength of concrete is very closely proportional to the cement content, although I am not making this statement in derogation of the investigations of the last few years in connection with designed mixes of concrete."

In Nebraska, according to A. T. Lobdell, chief of the bureau of roads and bridges of the Nebraska Highway Department, consideration is now being given to the question of changing the present requirements, which call for a cement content of 1.625 bbl. to the cu. yd. when two sizes of coarse aggregate are used, and 1.75 bbl. when sand-gravel aggregate is employed. The latter aggregate[1] is a glacial material found in eastern Nebraska and in parts of Kansas, and elsewhere. The particles are found in all sizes up to about 1½ in., though most of the material passes the ¾-in. screen and has a fineness modulus ranging from 4.10 to 4.50.

Less Cement with Two Sizes of Coarse Aggregate

The practice in North Carolina, where different cement factors are specified in stone and gravel concrete, is explained by John D. Waldrop, state construction engineer, North Carolina State Highway Commission. The specified proportions and the estimated cement factors are:

Mixture	*Cement Factor*
1:2:4¼ stone mix	1.42 bbl.
1:2:5 stone mix	1.32
1:2:4½ gravel mix	1.30
1:2:5¼ gravel mix	1.20

"In the stone mix requiring 4¼ parts of coarse aggregate," writes Mr. Waldrop, "and in the gravel mix requiring 4½ parts, the coarse aggregate is graded from coarse to fine, the sizes ranging from 2¼ to ⅛ in. In the stone mix requiring 5 parts of coarse aggregate and in the gravel mix requiring 5¼ parts, the coarse aggregate is separated into two sizes, the larger size ranging uniformly from 2¼ to ¾ in., and the smaller size ranging from ¾ to ⅛ in. In both the stone and the gravel mixes in which the coarse aggregate is separated into two sizes there is a reduction in volume of approximately 7 per cent when the material is mixed.

No Minimum Cement Factor Established

New York is one of the states where the cement factor can not be definitely stated, for the reason that it is dependent on certain characteristics of the aggregates. "Generally speaking," writes E. C. Lawton, construction deputy, Division of Highways, "we have not established a minimum cement content. Our proportions are determined by the voids in the sand and stone, and the cement factor is further dependent on the specific gravity of the aggregate to be used."

R. B. Gage, chemical engineer, New Jersey State Highway Commission, writes that the cement content of the concrete used in pavements in that state is practically uniform, since the amount of fine aggregate is a factor of the voids in the coarse aggregate.

"In Illinois," says C. M. Hathaway, engineer of construction, Division of Highways, "concrete is proportioned by the weight method, and we have established no minimum cement content. Occasionally the established proportions result in a rather low cement factor, in which case the amount of cement is arbitrarily increased."

Low Factor in Wisconsin

E. L. Roettiger, assistant construction engineer, Wisconsin Highway Commission, writes that in Wisconsin the cement content varies with the different aggregates employed, the exact proportions being based on designed mixes made in the department's laboratory. Minimum figures have been established, however, at 1.25 bbl. for concrete in pavements and 1.50 bbl. for concrete in structures.

Texas Making Special Study of Cement Factor

Texas, apparently, has gone much further than other states in the matter of low cement factors in concrete for highways. This question is discussed in considerable detail by Gibb Gilchrist, state highway engineer, who writes: "The Texas Highway Department has given considerable study, during the past year, to a reduction in the cement content of concrete used in paving work. We placed one 16-mile experimental job in Nueces County where the cement factor was varied from 4.25 bags per cu. yd. to 2 bags per cu. yd., the greater part being designed with 3.6 bags. This pavement has been down since July, 1931, and to date all sections are in good condition except one small section where 2 bags of cement were used and the aggregates were not properly combined to give the lowest voids.

"On one section where 2 bags per cu. yd. were used, and a small amount of very fine sand was added to the mix to reduce the voids, we have a very serviceable concrete which, in the 6 months it has been under traffic, has developed a small amount of scaling, but this is almost negligible. We are confident this would make a very satisfactory base for light asphalt surfaces.

"We have a number of sections over the state which have been placed with a cement factor of 3.5 bags per cu. yd. of concrete, these sections having been under traffic from 3 to 10 months, and from visual inspection they can not be distinguished from sections where 4 and 4.5 bags of cement were used.

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[1] See article by L. H. Koenitzer in January (1931) issue of CONCRETE, pages 29-31.

"At this time we are constructing a job in Carson County on 4 bags per cu. yd., also one in Potter County on this same cement factor, and we have one in Tarrant County, one in Bell County, and one in Victoria County, which will be started within the next 30 days, on 4 bags. We have not decided just what the minimum is going to be, but we are confident that we can make a satisfactory concrete with as low as 4 bags to the cu. yd. of concrete, in any part of the state.

"In reducing the cement factor we have found it necessary to go into a detailed study of aggregates. We have used two sizes of coarse aggregate in a great number of projects, and we have also used two sizes of fine aggregate in a great number of projects. We find that the percentage of voids in the fine aggregate has as great an influence on the workability of the concrete as the percentage of voids in the coarse aggregate.

"In going into the extremely low cement factors, we have in practically all cases found it necessary to use two sizes of fine aggregate. All of our design work is based on absolute volumes and we have equipment in the field to make all tests on the percentage of voids in aggregates, the specific gravity of aggregates and the percentage of moisture they contain, as often as necessary to control the batch and give a uniform workability."

(The use of two or more sizes of coarse aggregate will be covered in the next article in this series.)

Control Concrete on Koon Dam With Precise Equipment

Adjustments Made for Varying Moisture Content—Graphical Recording Instrument Makes Permanent Job Record—Specified Strength of Concrete Greatly Exceeded

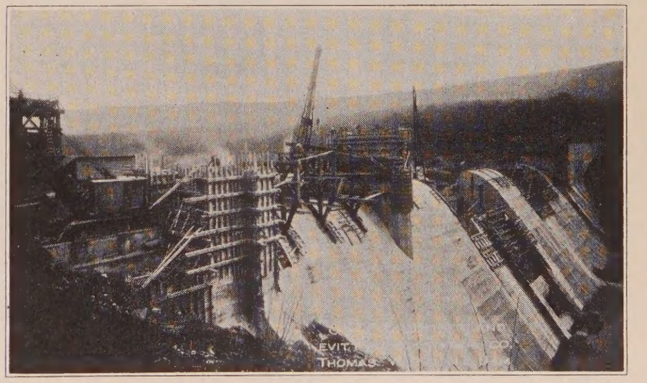
PREDICATED upon the presumption that the strength of concrete is a definite function of the water-cement ratio, and that precision in the control of the mix could produce strength for certain proportions hitherto unobtained, Major H. H. Allen, of the J. E. Greiner Company, consulting engineers, Baltimore, Md., prepared a specification for the weight proportioning of concrete for the Thomas W. Koon Dam, under construction 12 miles north of Cumberland, Md., which has produced a structure every yard of which has been under the definite control of the engineer.

Impounding 2½ billion gallons as supplementary storage for the city of Cumberland, Md., this project is located on Evitts Creek, which lies in Bedford County, Penna. It is located above the present water supply reservoir, which is known as Lake Gordon, and is approximately 67 ft. higher than the Lake Gordon level. The dam is of the gravity type, 726 ft. long, 92 ft. maximum height, surmounted by a highway bridge having a 22-ft. roadway, and two 4-ft. cantilevered sidewalks, carried over the four spillway sections by arches.

The operation of the batching equipment makes possible a semi-automatic batching and mixing plant operable by one individual, who controls all the operations by means of push buttons connected to a control panel, and a photo-electric cell in conjunction with the weighing equipment.

Producing Permanent Job Record

The outstanding feature of the method is a graphical recording chart of the continuous strip type upon which appears the exact weight of each ingredient, showing its net weight and the amount of surface moisture; showing also whether or not a moisture determination was made for any ingredient, and if so, the percentage of surface moisture present; showing whether or not compensation was made in the total batch water for the surface moisture so present; showing the time involved in each operation, and permitting of an autographic notation showing the destination of each batch or any other facts pertinent to the operating conditions, which should be noted.



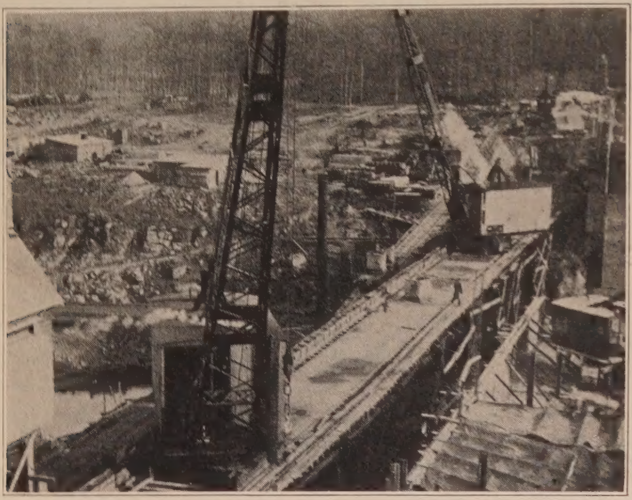
Downstream face of Koon Dam. In the foreground forms are being erected for abutment and pier of one of arches to support roadway across dam

This record can settle any dispute arising at any future time regarding the batching operation and becomes invaluable as statistical data in the job archives. It operates independently of the human equation and is, in addition to its value as a record, of enormous psychologic value in compelling the strictest attention on the part of all concerned.

Specifications

The specifications under which the control of the concrete was obtained are as follows:

Measurements—The amount of cement and the fine and coarse aggregates used in each batch of concrete shall be determined by direct weighing equipment complying with the following requirements:



Cranes operating on trestle distribute concrete in 2-yd. buckets

(a) The accuracy of the weighing equipment shall conform to the requirements of the United States Bureau of Standards.

(b) The equipment shall include a visible dial or equally suitable device which will accurately register the scale load at any stage of the weighing operation from zero to full capacity.

(c) The equipment shall include an accurate automatic recorder capable of being locked for visibly and graphically recording the time of weighing and the actual amount of each separate concrete ingredient weighed out.

(d) The equipment shall be capable of ready adjustment for compensating for varying weights of moisture in the aggregates or for changing the proportionate batch weights.

(e) The equipment shall be capable of controlling the delivery of material for weighing to within 1 per cent of the specified weight for cement and 2 per cent of the specified weight for each of the separate aggregates.

(f) The equipment shall be so arranged as to permit the convenient removal of over-weight material in excess of prescribed tolerances.

The amount of water shall be changed as required to secure concrete of proper consistency and to adjust for any variations in the moisture contained in the sand and other aggregates as they enter the mixer.

A two-yard mixer will be used with the approximate proportions of aggregates as follows: sand, 2,400 lb.; coarse aggregate, 4,500 to 5,000 lb.; cement, 1,200 lb.; water, 500 to 600 lb.; total, 9,000 lb.

The total cubic yardage of concrete will approximate 72,000, of which at this writing (January 16) about 60,000 cu. yd. have been placed. The specified 28-day strength of the main mass of the concrete is 2,500 lb. per sq. in., with small quantities of 3,000 and 3,500-lb. concrete for the superstructure, etc.

Use Large Sizes of Aggregate

A rock crushing plant was installed at the central mixing plant to which quarry rock is conveyed by a narrow gauge railway from a quarry some half mile upstream from the dam site. Three sizes of coarse aggregate are used, namely, ¾, 2½, and 3¼ to 6½ in., as well as a manufactured sand. The aggregates are conveyed by belt conveyors to the main bins. Bulk cement is used and conveyed from the delivery point in covered trucks.

Batching Plant

From the storage bins, the sand and aggregates are fed into the weigh-hopper by belt conveyors, motor driven, which are controlled from the weigh-house, as hereafter described. The cement is fed by a screw conveyor, also electrically operated and controlled from the weigh-house. The water, which is fed into a separate compartment of the weigh-hopper, is controlled by a valve operated by the weigh-man.

All the ingredients entering into the batch are weighed in one multiple compartment weigh-hopper, balanced on one set of levers and connected directly to the scale in the weigh-house.

Weighing Equipment

The weighing mechanism used is the Toledo springless double vertical pendulum type.

The scale is equipped with three double range beams, each equipped with two poises. A poise is allotted to each aggregate, and for convenience, adjustable poise-stops are set for repeating batches, the movement of which, when necessary, is compensated for by a quick-acting micropoise.

From the left of the beam assembly a container is suspended, equipped with a close fitting flanged lid so arranged that the weighing ratio is 1,000 to 1; in other words, one pound in the small container will pull 1,000 lb. on the chart. This affords a scale capable of weighing tons of material and at the same time, by means of the ratio of the container, actually sensitive to 0.01 lb.

Scale head, recorder, weigh beams and frame, in scale house. Panel on left shows controls by which materials are started to feed into weigh hopper

Operation of Batching Equipment

The *modus operandi* is as follows: A sample of the moist sand is placed in the ratio container, sufficient in quantity to bring the indicator from the starting position to the setting for the specific gravity constant. Sufficient water is placed in the container to cover the sand, which is then vigorously stirred for a few seconds to free the entrained air, whereupon the bucket is filled with water and the lid put in place, forcing an overflow; the bucket is wiped dry and the indicator moved to a position on a "percentage of moisture" chart which gives a direct reading of moisture percentage graduated by ½ per cent. Repeated tests have shown this percentage determination to be within 00.14 per cent accurate.

The reading is obtained as often as desired or directed by the engineer. The next step is the correction of the amount of the material. Inasmuch as this moisture determination can be made in from 25 to 40 seconds, it is quite feasible to do so in every batch.

The poise assigned to the material to be weighed is then set at the designated weight, which, because of the counterclockwise graduation of the main weighing chart, moves the indicator to that point and permits a check before any material is placed into the weigh-hopper. The percentage of moisture present is compensated for by suspending from the poise calibrated percentage weights which move the indicator still farther from zero by the actual amount of surface moisture present, so as to assure a net surface-dry weight of the ingredient to the required amount. By pressing a button on the panel board the flow of the material into the weigh-hopper is started. The indicator approaches zero as the material flows into the hopper and the cut-off is always effected at zero.

The operation is then repeated for each ingredient, moisture corrections being made in each desired case.

When all the materials are in the hopper, except the water, the water poise is set for the required amount, and the reading checked on the dial. Then by merely lifting off the percentage weights, which causes the indicator to return toward zero by the exact amount of surface moisture present in the batch, a definite and absolute compensation is made for moisture content.

The zero cut-off for each ingredient is made by means of a photo-electric cell. A paddle mounted on the indicator shaft is so arranged that when the indicator reaches zero, the paddle intercepts a beam of light shining through a slot in the dial on the sensitive cell. This closes the contact in the relay and stops the feeding motor, or, in the case of water, closes the valve.

Specified Strength Greatly Exceeded

With the full 1,200 lb. of cement in the 2-yd. batch, the strength of the cylinders showed in excess of 5,500 lb. per sq. in. With 900 lb. of cement the strength is in the neighborhood of 3,500 lb., and some test cylinders made with 600 lb. of cement, or 50 per cent of the expected mix, showed a strength in excess of 3,000 lb., as against the 2,500 lb. specified.

However, the cement factor being used is 4.5 bags per cu. yd., with a resulting dense and impermeable concrete. There is a marked uniformity in the breaking point of the cylinders, at both the 7-day and the 28-day tests.

Tamping With Electric Vibrators

The exact grading employed is producing a very harsh concrete, which is being successfully puddled into place by electric-driven vibratory tampers. With these tampers, one of which is illustrated below, the concrete is easily puddled in spite of the large sizes of coarse aggregate. A smooth surface is obtained, practically free from honeycombing.

The concrete is being placed by means of especially constructed, straight sided 2-yd. buckets, brought from the mixing plant on cars and lifted into position by means of cranes, mounted on a trestle, which surmounts the cofferdam. The distributing system is shown on the opposite page.

Electric vibrating puddler in use. Observe the harsh, coarse mix and large size aggregate

Acknowledgments

Ralph L. Rizer is city engineer of Cumberland, and the J. E. Greiner Co., consulting engineers, of Baltimore, designed the project. Professor John H. Gregory, who is dean of engineering of Johns Hopkins University, was associated with them in the design, and Wm. Willoughby, of the Greiner Company, is resident engineer. The dam is being built by the Evitts Creek Water Company, the corporate name under which the city of Cumberland is building this dam in Pennsylvania. L. E. Goerder and G. W. Smith are in charge of the job for the general contractor, the Vang Construction, of Cumberland. The technical control of the concrete is in the hands of R. E. Martin.

~ PERSONALS ~

Stanton Walker, director, engineering and research division, National Sand and Gravel Assocaition, has been appointed on the Joint Committee on Concrete and Reinforced Concrete. He succeeds Cloyd M. Chapman, who has resigned.

Harry S. Wright, formerly assistant manager of the structural bureau of the Portland Cement Association, and more recently with Stevens Master Specifications, Inc., of Chicago, has been appointed Boston representative of the Metal Forms Corporation, of Milwaukee, Wis.

Co-ordinate Basic Principles of Concrete Mixtures

New Series of Articles by Joseph A. Kitts Will Harmonize Principles Developed by World Authorities on Concrete—Scope to be Covered

THE first of a series of articles by Joseph A. Kitts, on "Co-ordination of Basic Principles of Concrete Mixtures," will appear in the May issue of CONCRETE.

With a background of many years of practical and technical experience in the making of concrete, and having had unusual opportunities to make an exhaustive analysis of the record of concrete research, Mr. Kitts has solved some of the very abstruse questions of that research and advanced the scientific and practical knowledge of the physics and technology of concrete mixtures.

Problems of Central Plant Production

This development, for the most part, has been made by Mr. Kitts in connection with the new and special problems of central plant production of concretes of any specified mix, grading, maximum size of aggregate, slump, strength, and the many other requirements of the buyer of ready-mixed concrete.

Co-Ordinating the Work of Other Investigators

Mr. Kitts has elaborated and harmonized the fundamental physics of mixtures discovered by others, made complementary discoveries, simplified and systematized laboratory and field technique, developed the physics and mathematics involved, co-ordinated all into a practical, scientific, and efficient concrete technology, and established a new basis for further research. This development is not controversial in character, for it co-ordinates the basic principles of mixtures advanced by Thacher, Feret, Fuller, Talbot, Abrams, and other noted workers in concrete research, without conflict. The complementary laws of mixtures, advanced by Mr. Kitts, are consistent with the established principles of mixtures.

Scope to be Covered

Some of the developments to be covered are:

(1) A co-ordinated, systematized and expedient field and laboratory procedure of pretesting materials and concretes, and of concrete research.

(2) The use, practically as well as technically, of absolute volume as the basic measure of ingredients.

(3) The physico-mathematics of measurement of absolute ("apparent") volume of materials by weighing, by loose-moist, loose-dry, or dry-rodded volume, or by inundation.

(4) The Kitts law of the optimum cement content for any maximum size of aggregate, strength and slump.

(5) The Kitts law of the optimum fineness modulus for any maximum size of aggregate and cement content.

(6) Elaboration of the Fuller and the Talbot-Richart grading equations for aggregate mixtures.

(7) Co-ordination of the Abrams' fineness modulus principle with the Talbot-Richart grading equation, providing an expedient algebraic method of determining proportions of three, four, five or more size separations of aggregates for grading uniformly to a given fineness modulus.

(8) Analysis and application of the Abrams law of the water-cement ratio for any strength.

(9) Appreciation of the voids and density theories of proportioning.

(10) Elaboration of the Feret law of yield of combinations.

(11) The Kitts law of the optimum slump for any maximum size of aggregate.

(12) Development of the physico-mathematics of materials and mixtures, empirical equations, and a complete calculation method of proportioning.

(13) Co-ordination of these laws and developments for practical use in preliminary, routine and research tests, and for technological control of production.

Related Laws of Mixtures

This co-ordination supplies the following related laws of mixtures, providing a complete calculation method of mixture formulation and comprehending the established fundamentals of mixtures:

(1) Law of the optimum cement content for any maximum size of aggregate, strength and slump of concrete.

(2) The law of the water-cement ratio.

(3) The law of the aggregate content.

(3a) The corresponding law of the optimum fineness modulus for the given cement content and maximum size of aggregate.

(3b) The corresponding grading equation for the given fineness modulus and maximum size of aggregate.

(4) The law of the yield of combinations of ingredients.

The practical application has been presented under the title "Co-ordinated Laws of Concrete Mixtures and Their Application" in the November and December (1931) issues of CONCRETE. The methods of determination of the physical characteristics of aggregates, and of calculation of mixtures of any maximum size of aggregate and strength and slump of concrete, are simple and fundamental and readily acquired by the technical student. However, the derivations of the various laws and their empirical constants are more complex matters of concrete physics and mathematics which Mr. Kitts will unravel in the forthcoming series starting next month.

Eliminate All Plaster in Building for Marquette University

Interior Walls and Partitions Finished With Concrete Units—Pilasters and Ceilings of Monolithic Concrete Finish Formed With Plywood

THE new medical building for Marquette University, now under construction in Milwaukee, Wis., is a noteworthy example of the complete elimination of interior plaster work through the use of concrete units and monolithic concrete, the latter formed with plywood.

Concrete Back-Up and Partition Units

The structural frame and the floor construction of this building are of reinforced concrete. The exterior panel walls consist of 4 in. of brick facing and 8 in. of hollow concrete back-up units, 8 by 8 by 16 in. in size, the total wall thickness being 12 in. The brick facing is tied back into the concrete back-up units by means of corrugated galvanized iron ties.

Concrete units and monolithic concrete finish to eliminate all interior plaster work

All interior partitions are 5 in. thick, built of 8 by 5 by 16-in. hollow concrete units.

Around the base of walls and partitions, at each floor level, a black concrete unit is placed as the first course appearing above the floor level. These units are 4 in. high and 16 in. long. A black mineral color was employed in their manufacture.

Interior Finish Partly of Exposed Concrete

On the exterior side of the reinforced concrete wall columns, or pilasters, the brick facing continues around the pilasters. On the interior the wall pilasters, the interior columns, and the ceiling beams and flat surfaces, all are left in an exposed concrete finish, no treatment of any kind being resorted to after the forms are removed.

The smooth surface shown in the illustration is typical of the exposed concrete finish throughout the building. It was obtained through the use of 9/16-in. plywood, made by cementing five veneer layers with glue, the grain of each successive ply being reversed. This form material is supplied in large sheets, usually ranging in width from 2 to 4 ft., and in lengths of 6, 8 or 10 ft.

No Additional Finish in Class Rooms

The intention is to apply a paint or stain to the walls and ceilings in the public parts of the building; but in the class rooms the concrete partition units and the monolithic concrete surfaces will constitute the wall and ceiling finish, exactly as left by the workmen. In this way all plaster work throughout the building is eliminated.

Large Saving Attained

The saving attained in the elimination of plaster may readily be estimated by architects, on the basis of local costs, from the fact that the total wall surface of the partitions is about 240,000 sq. ft., counting each side of the partition, and the interior wall surface on the outside walls is about 75,000 sq. ft. Thus a total of about 315,000 sq. ft. (35,000 sq. yd.) of plaster work has been dispensed with.

An interesting feature of the plans for the building is the fact that all dimensions for door and window openings, pilasters, panels, offsets, and other features, were worked out to block lengths.

Acknowledgments

All concrete units, including about 70,000 8-in. back-up units and about 135,000 5-in. partition units, were manufactured by the Best Block Company, of Milwaukee. The plywood used in this work is known to the building trade as "plycrete," manufactured by the Harbor Plywood Corporation, of Chicago.

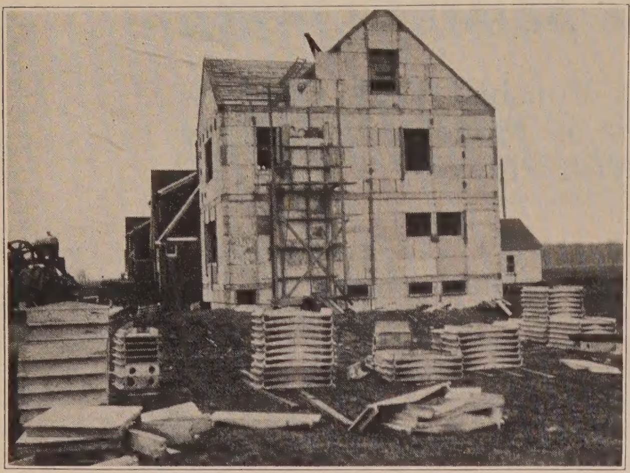
Kirchhoff & Rose, of Milwaukee, are the architects, and the general contractor is the Selzer-Ornst Company, also of Milwaukee.

New Concrete Building Unit for Floors and Walls

A new type of concrete unit is being employed in the construction of several dwelling houses in Detroit and vicinity. The same kind of unit is used in exterior and interior walls and in floor and roof construction, so that all structural parts of the building are fire-resistive.

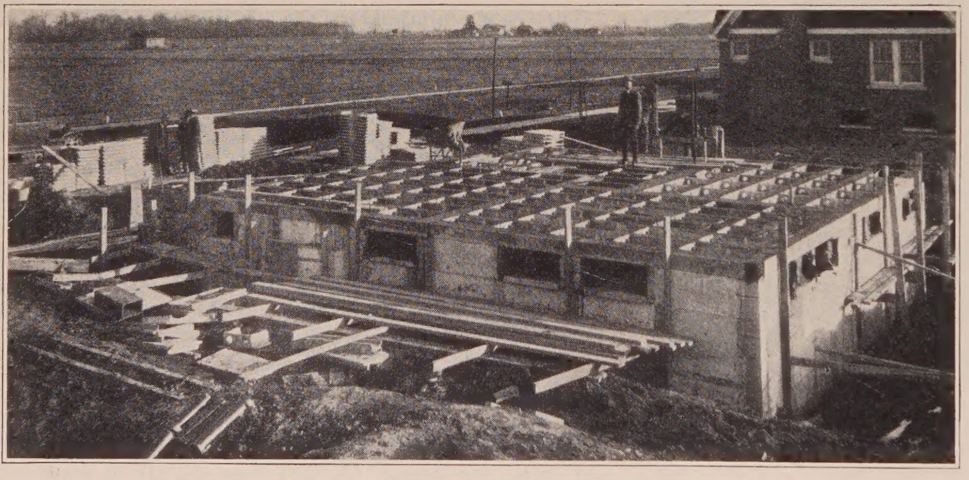
The illustrations show a dwelling under construction in Gleason Ave., near Plymouth Road, in Detroit. A number of the units may be seen in the foreground.

In floor construction these units are placed on shores, with the flat side down to form the ceiling. The lips at each of two edges form channels when placed adjacent to other units. Reinforcing bars are placed into the channels, and the floor is concreted.



This concrete building unit is used in the walls, partitions, floors and roof of this Detroit dwelling house

Wall construction is accomplished by placing units on both faces of the wall. In this case the lips along the two vertical edges of the units form rectangular spaces which are filled with concrete after steel bars are set into the space. In this manner reinforced concrete posts occur at intervals equal to the width of the units, and air spaces occur between posts.



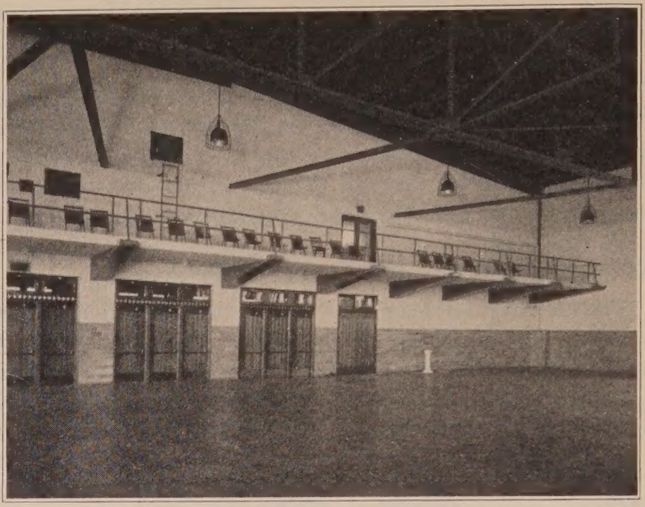
Foundation wall erected and first floor units in place, ready for concreting

These units are made by the Concrete Unit Manufacturing Co., which has its plant at Pontiac, Michigan. The builder of the house here illustrated is Ralph C. Vokes, of Detroit.

Light-Weight Units in Armory Walls Improve Acoustics

The Michigan Naval Reserve Armory, in Detroit, built in 1930, represents a recently developed special use for concrete masonry units made of special materials.

For the purpose of obtaining satisfactory acoustics, the exterior walls of the armory were backed with haydite concrete units. Then, instead of plastering the interior, the sound-absorbing property of the concrete units was retained by omitting interior plastering and leaving the units exposed. Only a spray coat of paint was applied to the walls, as the illustration shows. Similar masonry units, similarly treated with a spray coat of paint, were used in the interior partitions.



Interior of Michigan Naval Reserve Armory, Detroit. Exposed concrete units in surrounding walls have only spray coat of paint

More than 75,000 back-up and partition units were utilized in this structure, which was designed by Stratton & Hyde, architects, of Detroit. The armory was built by the Walbridge-Aldinger Company, general contractors, of Detroit.

Iowa Products Manufacturers Meet at Des Moines

Members of the Iowa Concrete Products Association met in their annual meeting on March 10 at Des Moines.

Officers elected for the coming year are R. H. Stetson, Des Moines, president; H. L. Spaight, Cedar Rapids, vice-president; W. M. Alsin, Des Moines, secretary-treasurer.

Fireproofing Steel-Framed Buildings With Cinder Concrete

Placing Wire Fabric—Crude Methods of Proportioning and Mixing—Curing Not in Evidence—Stripping Crews Work Fast But Waste Little Material—Conclusions

By J. ARTHUR GARROD
Superintendent of Construction, Boston, Mass.

This is the final installment of the author's detailed description of New York City practice in the fireproofing of steel-framed floors with cinder concrete. Two previous articles appear in the February and March issues of *Concrete.* — The Editors.

IN this installment the subject matter includes the placing of steel reinforcement, outlet boxes and conduits, the proportioning, mixing and placing of concrete, stripping the forms, and finishing exposed surfaces, as observed by the writer in his study of the methods followed in New York City in fireproofing steel-framed floors with cinder concrete.

Placing Steel Reinforcement

Aside from the girder and beam wrapping which has already been referred to as being placed by the wire lather,[1] the slab reinforcement is placed by the steelman, in accordance with the engineer's designs or according to designs of the fireproofing contractor which comply with the architect's and the city building department's requirements.

Wire Fabric Reinforcement Preferred

The form of slab reinforcement preferred was the electrically welded wire fabric. This material is made with appropriate sizes and spacing of high tensile strength drawn steel wire to meet the requirements of varying spans and loadings. The transverse wires insure accurate spacing, and the large sized rolls of continuous fabric make it economical to apply.

It is the common practice to fill the haunches of girders and beams and to place an inch of cinder concrete upon the slab forms; then to roll out the reinforcing fabric over the tops of the beams so that the mesh will sag to within ½ in. of the forms in the center of the slabs.

Besides bending the ends of the main longitudinal wires over the structural steel members at the outer spans, the wall spans usually receive an additional layer of the same mesh and size of wire utilized for the regular interior slabs.

Placing Outlet Boxes and Conduits

The contractor for electrical work places his outlet boxes and conduits during the same periods allotted to the placing of reinforcing. Especial care is necessary to insure against delay to concreting because of lack of sleeves for plumbing and heating pipes or other pipes or inserts.

Where a suspended ceiling is to be built, toggles of the conventional shape, made of 1-in. channel-iron section, are inserted at about 4-ft. intervals in the form work with an embedment of about 2 in. into the concrete.

Proportioning, Mixing and Placing Concrete

The materials for concreting are delivered at the building as required, with little or no provision for storage.

The portland cement is of any standard brand and is usually in cotton duck sacks. The sand is trucked from water-side yards as needed. The cinders are trucked from power-houses in the city. They are not piled and weathered. It is said that no trouble develops with regard to satisfactory setting qualities. From observation I noticed that the cinders contain a proportion of over-sized clinkers which are too large for use in haunches or the slab.

Puddling and Tamping the Concrete

The standard mix is 1:2:4. The mixture used for the lower parts of the fire protection, a portion of which must be worked in under the bottom flanges of the steel members, is noticably more sandy than the mix utilized for the remainder of the beam fireproofing and for the slab concreting. This bottom concrete, called "soup" by the workmen, is so wet that the barrows conveying it are not loaded above 6 in. from the top. The remainder of the concrete was dry enough to be wheeled without slopping if filled slightly higher than the sides of the barrow. The "soup" requires careful rodding and spading. The remainder of the concrete required tamping. This was done with a hardwood tamper 16 in. square.

Proportioning and Mixing by Crude Methods

The proportioning is done by the same large wheelbarrows used for conveying the mixed concrete to place. The mixing is hurried. New material is dumped into the mixer before the last of the former batch is discharged. Apparently much reliance is placed in the mixer-man to see that the resulting mixtures are likely to result in usable concrete.

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[1] February (1932) issue of CONCRETE, page 14.

The mixed concrete is usually dumped into a hopper and from thence into wheelbarrows. The barrows are raised by rapid hoists to the floor where concreting is in progress. As previously explained, a soft mix with less cinders and some excess water is used for the lower third of all structural steel members and a drier mixture with the full proportion of cinders is used in the upper two-thirds of the beams and the slab.

Curing Not in Evidence

The curing is, or should be, cared for in the same way as is done with stone concrete. My visit was during the winter, and I observed that no sprinkling or other means of keeping the new work damp was in evidence.

Concreting is not started when the thermometer registers 30 deg. and is falling, and the work is discontinued at 20 deg. Concrete is prevented from freezing by the use of coke-burning salamanders for the first 24 hours after placing. It is claimed by the foremen that longer heating is not necessary with cinder concrete. Stripping of forms is begun on the third day during summer weather and on the fifth day in winter.

Stripping of Forms

The stripping is accomplished by a pair of men, who erect their own stages, usually with horses and planks, but in the higher stories they use the wire loop hangers before mentioned.[2]

The wire stirrup hangers are first severed by a bolt cutter, the "hangers" or bottom beam joists are easily removed and laid parallel with the beams upon the stripping stage. The "spreaders" or upper joists are now easily removed, since they are not at right angles to the beam sides.

The wires under the girder-bottoms are now cut, and beam sides, beam bottoms, girder bottoms and girder sides are readily detached with little breakage of lumber. The long lengths of cover-over boards are more readily taken down because of the reversed boards at the end. All removed form lumber is laid parallel with the beams and is handed down by the helper to the floor, in readiness for re-use on a higher floor.

My attention was directed to a fast stripper, who removed all form lumber from a 5 by 15-ft. bay in six minutes. The stage was in place before he started, the lumber was not all off the stage when he had completed his work, but the operations were rapid, decisive, and efficient. His performance would be difficult to excel.

Little Wastage of Lumber

When stripping was completed on any one floor and the forms had been carried up the stairways to the floor above, the amount of scrap lumber was small, particularly so when compared to the waste in building forms for a reinforced concrete structure.

The surfaces of the cinder concrete needed no patching or chipping. The work as left by the forms was entirely acceptable for direct application of plaster.

On the first floors of the buildings I inspected, stone concrete was used instead of the cinder concrete used on the upper floors. Where so used, plastering was omitted in the basement. The results on these unplastered ceilings were not satisfactory. The fireproofing contractor was going to considerable expense to correct the lines and fill the voids by using a cement finisher. My belief is that a small amount spent on a more careful job of forms would have been less expensive than the more costly plastering work.

Conclusions

The cinder concrete floor arch has met with general acceptance in constructing fire-resisting floors in New York City. The system will probably hold its own against other methods of fireproofing while the materials which enter into its construction remain plentiful.

The resulting floors appear to be adequate and adapted admirably to the placing of inserts and the passing of pipes. The floors can be cut in two without undue expense and can be patched after alterations, with reasonable certainty of success. They receive plaster admirably and seem to afford sufficient bond to insure permanent adhesion.

The cinder concrete in its early stages of hardening can receive and hold a nail well, and when fully hardened it affords excellent attachment for expansion bolts.

The top surface can become an excellent base for cement finish, or as a base for linoleum in offices, or for terrazzo in corridors or toilet rooms.

Cinder concrete weighs about one-third less than stone concrete, and as an insulator and sound deadener it is superior to stone concrete.

In the building of such floors the problems of forming, reinforcing, mixing, placing and stripping have been adequately met by the fireproofing contractor. He handles the various skilled trades and skilled laborers with judgment developed by experience. His ingenuity has been exercised to a marked degree in meeting active competition.

The methods the fireproofer adopts in New York are worthy of adoption in any city where such work is to be done; but the advantage he possesses over the general contractor who would do his own work decreases or disappears as he gets away from the specialized workers he can command in the metropolis.

Coming Conventions

May 2-6—American Waterworks Association and Waterworks Manufacturers' Association, annual meeting, Memphis, Tenn.

May 19-25—International Association for Bridge and Structural Engineering, first annual meeting. Paris, France.

June 20-24—American Society for Testing Materials, thirty-fifth annual meeting. Haddon Hall, Atlantic City, N. J.

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[2] March issue of CONCRETE, page 9, first column.

EDITORIAL

Where Public Expenditures May Be Cut

SOME forms of public expenditure involve the creation of improvements that are so essential to the continued growth and welfare of this country that no amount of false "economy" should be allowed to interfere with the normal progress of the work. Expenditures for concrete highway construction occupy a high position in this group.

The hysterical demands for reduced taxation have in many cases forced state, county and city officials to cut expenditures without regard to true values. No distinction has been made between essentials and non-essentials. Too often the heaviest cuts have been made in essentials such as road building.

Public officials and public-spirited citizens alike should study and assimilate a published analysis made several months ago by B. F. Affleck, president of the Universal Atlas Cement Co., an abstract of which appears on page 69 of our January issue.

Mr. Affleck divides tax expenditures into four general groups. In the first group he places the funds that are wasted.

In the second group he places funds that are spent injudiciously for purposes from which little or no benefit is derived.

The third group includes funds spent for necessary things, but where the amount spent is far out of proportion to the benefits.

Finally, he places in the fourth group the funds spent for necessary and beneficial purposes such as good roads, from which nearly everyone benefits.

Only in isolated cases do public officials have the broadness of vision to see the distinctions between these four groups of expenditures; or, if they do see them, they lack the driving power necessary to force appropriate action.

Well-organized committees of influential business men have, in several cities, undertaken to point out to the public officials the places where expenditures can be reduced without crippling needed services and improvements. Almost every city needs the help of such a committee; and the construction industry should see that it is well represented.

Building Without Overbuilding

WHOLESALE improvement of tenement districts as a business-creating activity was recently advocated in an address by E. J. Mehren, president of the Portland Cement Association.

The slum areas of our big cities, he pointed out, are a disgrace to American life, breeders of disease and crime. Had we the imagination and the courage to embark upon a wholesale cleaning out of the slums, and their replacement with fireproof and sanitary tenements, we should have no further need to seek an immense prosperity-creating mechanism.

The modernizing of tenement districts has something further to commend it. Instead of creating more dwelling places, which might soon lead to an overbuilt condition, it only creates modern dwelling units in place of the miserable hovels that now exist.

Plus Signs in Concrete Products

UNDER the heading of "Plus Signs," an item printed recently in "Sales Management" and in the Knoxville, Tenn., "News-Sentinel" reports the incorporation of a company for the construction and operation of a plant to manufacture varied lines of concrete products. The organization is to be capitalized at $50,000, and several men who are well known locally are associated with the enterprise.

In this item the reference to various lines is significant; so is the mention of well known men.

The concrete products industry is no longer a one-man affair. It is an industry of varied types and kinds of products whose manufacture demands the attention of able men.

A Public Project That Yields An Income

THE building of an outdoor swimming pool is not a major construction project; but when the cost of the average pool is multiplied by the number of towns and cities that have no natural bathing beaches and no swimming pools, the total reaches an enormous figure.

In communities not having natural bathing facilities, a publicly built and publicly owned swimming pool can and does return a dollars-and-cents profit on the investment. The truth of this assertion has been demonstrated many times over.

What better movement could be initiated by local organizations than the promotion of an outdoor swimming pool? Its construction would provide a moderate amount of employment and the purchase of moderate quantities of material. When completed, it would provide summer employment for several people, besides bringing revenue into the treasury.

In hundreds of towns and cities the need for an outdoor pool exists. Its worthiness as a public works project can not be assailed on any reasonable grounds. Local men of the concrete construction industry are best qualified to get behind a promotional effort of this character. Now is the logical time to push the opportunity.

PROGRESS—In a Page

Current activities in research, in matters pertaining to concrete and cement, as being carried on or completed by various organized groups.

Standard Concrete Block and Tile Sizes to Be Revised

REVISION of Simplified Practice Recommendation No. 32, Concrete Building Units, approved May 1, 1925, is proposed in a letter-ballot being sent out as a result of action taken at the annual meeting of the Concrete Masonry Association held in Washington, D. C., on March 1 and 2.

In the block and tile groups the proposed standard drops all the old partition tile sizes and provides other sizes that are in conformity with the practice that has developed since the adoption of Simplified Practice Recommendation No. 32. An outstanding feature of the proposed standards is the inclusion of five sizes having nominal wall faces of 12 by 24 in., the widths of these units being 2, 3, 4, 6 and 8 in. In actual construction practice these units have found increasing use in partitions, as fireproofing, as facing units, and elsewhere.

The proposed new standard sizes for load bearing and non-load bearing concrete block and tile follow:

LOAD BEARING AND NON-LOAD BEARING CONCRETE BLOCK AND TILE

Height, inches	Width, inches	Length, inches
7¾	12	15¾
7¾	10	15¾
7¾	8	15¾
7¾	6	15¾
7¾	4	15¾
7¾	3	15¾
11¾	8	23¾
11¾	6	23¾
11¾	4	23¾
11¾	3	23¾
11¾	2	23¾
5	7¾	11¾
5	5¾	11¾
5	3¾	11¾
3½	7¾	11¾
3½	5¾	11¾
3½	3¾	11¾

Tolerance. The permissible variation over or under the above dimensions shall not exceed ¼ in. in the case of block and tile.

Face and Common Brick. In this group the sizes are retained as in the old standard, at 2¼ by 3¾ by 8 in., but the tolerance is changed to conform to those adopted for brick of other kinds of material. The permissible variation over or under these dimensions shall not exceed 1/16 in. in height, ⅛ in. in width, and ¼ in. in length.

Treatment of Icy Pavements

A RECOMMENDED specification for the treatment of icy pavements is included in a paper presented by B. C. Tiney, engineer of maintenance, Michigan State Highway Department, at the last annual meeting of the Highway Research Board, 2101 Constitution Avenue, Washington, D. C.

The specification recommends the use of sand or cinders, and the use of calcium chloride to cause partial melting of the ice and consequent embedding or partial embedding of the sand or cinders.

Twelve New German Patents for Producing Glossy Finish

A news item printed on page 31 of the March issue of CONCRETE contains a brief description of a newly patented German process for producing a glossy finish on the surface of cast concrete without resorting to mechanical polishing.

Further investigation by CONCRETE has disclosed the fact that about twelve new patents covering processes for producing glossy finishes on cast concrete have recently been granted by the German patent office. Copies of the patents may be obtained at 1.00 Mark (24 cents) each direct from the patent office by addressing Reichspatentamt, 103 Gitschinerstrasse, Berlin, S. W. 61, Germany.

Credit is due George S. Messersmith, American consul general, for this information.

List of Simplified Practice Recommendations

THE following simplified practice recommendations of interest to the concrete construction industry are included in a list recently issued by the Division of Simplified Practice, National Bureau of Standards, Washington, D. C.:

No. 26-30. Steel Reinforcing Bars (2nd Edition).
No. 32. Concrete Building Units.
No. 53. Steel Reinforcing Spirals.
No. 87-29. Form Dimensions for Concrete Ribbed Floor Construction.

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C.

New A. S. T. M. Committee on Concrete Pipe

BY action of the executive committee of the American Society for Testing Materials, the subjects of clay pipe and concrete pipe will no longer be considered in one standing committee of the Society as heretofore, in Committee C-4 on Clay and Concrete Pipe. The committee is to be reorganized as Committee C-4 on Clay Pipe and a new standing committee of the Society, Committee C-13 on Concrete Pipe, will be formed. The scope of this new committee will be such as to include concrete pipe for sewers, culverts, irrigation and water supply purposes and similar uses.

The Fundamentals of Good Concrete

Must be Impermeable to be Durable—Designers and Specification Writers Need Knowledge of Concrete Making—Value of Trained Inspection

By D. B. RUSH
Manager, Cement and Concrete Dept., Robert W. Hunt Co., Chicago, Ill.

Two previous installments in this series of seven articles on testing, inspection and field supervision of concrete work were written by Richard H. Vose. The present article continues the general subject, with a discussion of the fundamentals of the science of making concrete.

The four articles to follow will cover various phases of the work involved in getting a quality in the structure equal to the quality assumed in the design.—The Editors.

THE use of cementing materials goes back to ancient times. Two hundred years before Christ a crude lime plaster was being used. In the times of Nero and Trojan a lime rock was crushed to form puzzolan cement. This cement, with aggregates of tile or stones, was the primitive forerunner of concrete.

Later, the natural cements, such as Rosendale, began to be used, but it was not until 1824 that portland cement as we know it today was invented.

Although the present-day cement has been in existence for more than 100 years, concrete began to come into use only about 40 years ago. Yet the growth which this new material of construction has enjoyed within these last 40 years may be measured by the miles of concrete roads and multitudes of buildings and bridges, large and small, which have come into existence in this short time.

Entering Third Stage of Development

There are three distinct stages in the development of every science. First, the primitive or awakening stage; then the middle period when knowledge comes fast and confusingly; and last, the time when the science becomes more or less fixed, principles are accepted and standard methods of procedure followed.

Concrete has gone through the primitive stage. In the early days of the present century all that was known of concrete was that cement, sand, stone and water, when mixed and dried, took on the properties of stone. No ideas were formulated as to how much of each ingredient to use, the effect of mixing, or the effect of deleterious materials. As a result, failures were not infrequent. A study of the literature of those days shows clearly the groping that was taking place to find some satisfactory formula which would act as a guide to dependable concrete. The importance of testing aggregate was considered; sand was investigated as well as gravel and stone. Papers were written on the effect of sugar and salt in the mixture. Debates were hot as to lean and rich mixes. In the meantime failures kept occurring and concrete came near the brink of discredit several times. Finally, the fineness modulus theory was promoted by Duff A. Abrams, of Lewis Institute. The middle stage had been reached.

The middle stage began about ten to fifteen years ago. One structure, the Baha'i Temple at Wilmette, Illinois, was begun before this period actually had effectively started; work was stopped for a number of years because of lack of funds, and just recently resumed, using the methods of today in concrete control. We thus have a building embodying the methods of both periods in its construction.

Beginning of Scientific Treatment

The proposal of the fineness modulus theory led to the water-cement ratio law, as it is generally referred to today, and testing and research laboratories all over the world began to conduct tests along these lines. Formulas were devised by which engineers would control the quality and strength of the concrete. The great trouble was that no two people agreed on exactly the same formula. Mr. Abrams' original formula gave results that were too high and consequently uneconomical. More experiments and variations were the order of the day. Finally, however, some sort of order was brought about. We learned the importance of the cement, fine and coarse aggregates, water, and how to devise mixes of these materials to insure fairly uniform results. Whether our knowledge is great enough to qualify our entering the third period of concreting science can not be said. Theories are coming less swiftly than a few years back, and it may be that practice will become sufficiently stabilized to set up standardized procedures. It would seem so, unless some startling innovation should come in.

Concrete is controlled by carefully analyzing and testing the cement, sand, gravel and water; putting these four together according to a prescribed formula and mixing thoroughly. To test the results, concrete cylinders are made, properly stored for three, seven or twenty-eight days, then crushed. If the crushing tests are satisfactory it is assumed that the concrete in the forms is also of that strength.

Concreting Is Work for Specialists

It is needless to point out that the utmost care should be taken in the design and control of concrete. Because it is a new science too much should not be expected of the contractor; changes are constantly being made in what is considered the proper procedure. The job of concreting is that of the specialist. A few years ago any attempt to control the mix scientifically was looked on with distrust by the contractor. Specifications usually gave the mix to be used and there was little the inspector could do beyond seeing that the materials were satisfactory, that they were properly proportioned, that the mixer was kept going long enough, and that the batch was placed right.

Unfortunately, due to the general lack of accurate knowledge on concrete, specifications could not be written with any great degree of accuracy, and even though the inspector did see that the engineer's or architect's instructions were followed to the letter, it did not necessarily follow that a good job of concreting was to be had. More recently the tendency has been to specify that concrete be of a certain strength. Now this requirement is perfectly satisfactory as such, but it does not completely fulfill the requirements of good concrete.

It is a comparatively simple matter now to design concrete for a certain definite strength and then control the mixture so that this strength is actually and uniformly produced; but there are several problems, such as permanency of the concrete, that are yet to be solved satisfactorily.

Higher Early Strength Appears

Concurrently with the establishment of various methods of designing concrete, cement manufacturers began to compete with one another in the manufacture of cements that gained high strength at comparatively early ages. Unfortunately, the result of this practice has been that the trade in general has been misled by the high early strengths exhibited, and bases its judgment on the gain in strength exhibited by the older types of cement, reducing the quantity of cement in the mix until the resulting concrete shows quite a high absorption coefficient and a resulting increase in permeability.

Concrete Must Be Impermeable

The consensus at present is that the life or permanence of exposed concrete is more a function of its permeability than anything else. In other words, if concrete is to be permanent it must be made waterproof. Water or moisture does not really pass through the concrete, but passes through the voids and honeycombing in the concrete. Consequently, the best method of reducing the permeability is to make the concrete itself just as dense and uniform as possible. While the accurate control of the amount and quality of the aggregate and water is important, it is of vital importance that the cement itself be satisfactory in quality, and of a sufficient quantity, regardless of the resulting early strength, to fill completely the voids between the particles of aggregate.

Designers Should Understand Concrete

The designing engineer and specification writer must have a fairly complete knowledge of concrete if his plans and specifications, when properly followed, are to result in a high-strength, uniform, permanent structure. If in these specifications he gives the contractor the proper information upon which to estimate the job, he will find that the average present-day contractor, with the assistance of a properly and scientifically trained man, will produce the desired results.

Function of Cement

Referring to the importance of the various ingredients of concrete, it is difficult indeed to select the one of either the greatest or least importance. It is, however, safe to say that no concrete whatever can be manufactured without cement, and that in general the principal strength of the resulting concrete depends upon how firmly both the fine and coarse aggregate are glued or cemented together by this cement—and the strength of this gluing ability of the cement is dependent in a general way upon how much it is diluted with water.

Avoid Dilution of Cement

In general, the saving in cement can be much better accomplished by increasing the size of the aggregate, than it can by reducing the water content. The water content must be a function of the character, size and shape of the section to be placed. Common sense must lead any thinking person to the realization that he does not want to dilute the cement with any more water than he can help; but this same common sense will tell him that it is much better policy to add a sufficient amount of water to his mixture to make it plastic and to make it possible for proper placing, than it is to keep the mixture abnormally dry and obtain concrete having erroneously high early strengths—that may crumble and disintegrate within a few years.

The ultimate object in the mind of the architect or engineer must be considered with extreme care in his preparation of the plans and specifications. If this is done and these specifications are not just a copy of specifications that have been a growth over a period of years, and used for every type of structure, it is our firm belief that the results will justify the fondest expectations of the designer.

Value of Trained Inspectors

As a rule it requires the services of an expert in concrete to apply these specifications properly with the innumerable brands of cement, practically every one of which requires a slightly different amount of water for the same consistency, and results in different early and ultimate strengths. Added to this are the innumerable kinds of both large and fine aggregate that are used.

There was a time when a field inspector placed on a concrete job was just a general nuisance. Unfortunately, many of them still are. However, the proper kind of an inspector, thoroughly trained in the knowledge of the use and combinations of cements, water and aggregates, is now almost invaluable to the contractor and the architect and their superintendents. The total expense of such a man's time, and all of the testing work involved, is less than is normally spent in patching up honeycomb spots that are the result of lack of knowledge and experience.

How Single-Lane Concrete Roads Fit Into Highway System

Roads of This Type Divided Into Three Classes—Purpose of Single-Track Roads—Present Mileage and Costs per Mile

By E. M. FLEMING
Manager, Highways and Municipal Bureau, Portland Cement Association

ENGINEERS, even more so than laymen, when brought face to face with a single-track concrete road, immediately see many faults with it and very few virtues. Like most good things, a single-track road must be studied carefully to get a thorough appreciation of its values. The more it is studied and its use analyzed, the clearer its virtues appear and the fainter become its faults.

The Purpose of Single-Track Roads

To get a correct picture of the values of a single-track road we must first of all divorce our thinking from the inhibitions built up by many years of building main highways and devote ourselves to a consideration of the particular objectives to be accomplished in constructing local roads.

It will serve to emphasize the importance of this type of construction to realize that during 1931, 240 miles of single-track concrete pavements were built. This work was awarded in 39 counties in eleven states scattered throughout the country. In addition, about 51 miles of single-track concrete built in previous years were widened to double width. The total mileage in use today, either as single track or as a part of full width paving, equals 3,000. This mileage is found in 207 counties in 30 states. Most of it is still single track, only a relatively small percentage having been widened.

Counties Continue Building Them

The single-track concrete road has proved to be an economical solution of the local road problem, because it presents all of the advantages of a double width concrete road at about one-half the first cost of the latter. It is significant that practically all of the counties which have built it to any extent have continued to increase their mileage year after year.

Cost Data on Single-Lane Roads

The cost of single-lane roads will, of course, vary widely for different conditions and in different sections of the country.

In Porter County, Indiana, last year, the average cost per mile complete was $9,766. This included a 9-ft., 9-6-9-in. slab, and a 5-ft., 4-in. traffic-bound macadam shoulder on one side. Awards in Vermilion County, Ill., were made during 1931 at an average cost per mile of $14,800 for a 10-ft., 9-6-9-in. slab, with 6-ft. gravel feather-edged shoulders on each side. In Iroquois County, Ill., 5 miles were awarded recently for $12,500 per mile complete. Earth shoulders were used. On May 7, 1931, 17.7 miles of 9-ft. road with earth shoulders and a 9-6-9-in. section were awarded by Champaign County, Ill., at an average price per mile of $12,562. Pierce County, Wash.,

Milk trucks operating on single-track concrete road in Ohio

A 9-ft. single-lane concrete road located in Dyer County, Tenn.

Condensed from paper read before the annual convention of the American Road Builders' Association, Detroit, Mich., Jan. 11-15, 1932.

on May 7, 1931, awarded 3.6 miles of 9-ft. single-track concrete, with a 9-ft. gravel shoulder on one side, for $10,000 per mile. A 9-6½-9-in. slab section was used. In Bay County, Michigan, awards this year average $9,000 per mile with earth shoulders, but gravel will be applied later.

These figures and others show that the single-track concrete road, while costing somewhat more than most types advocated for this field, still leaves it very much within the reach of justifiable expenditures.

Three Classes of Single-Lane Roads

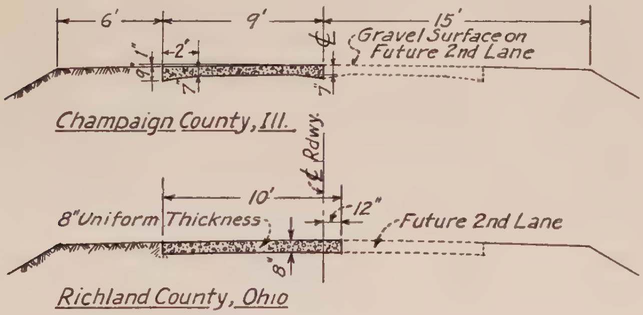
In studying the field for single-track concrete roads, three conditions are presented where such roads can be used to advantage:

1. On roads on state or county systems that carry traffic of less than 500 vehicles per day now, but that will obviously need widening soon, when funds permit, because of traffic increases that can be definitely predicted.

2. On roads on state or county systems that will probably develop traffic densities requiring widening but the date of which is so far in the future that it can not be definitely predicted.

3. Roads in county and township systems having present low traffic densities and upon which no appreciable increase in traffic is probable.

Each of these classifications should have different design requirements for grade line, alignment and drainage structures. Merely because a concrete slab is to be placed on a road does not necessarily imply that all the refinements of trunk-line design must be observed. A single-track concrete road is not a high type road in the accepted sense; it is an intermediate road and it should be laid on a roadbed that is no better than is used for other types of roads of its class.



Single-lane concrete roads in Champaign County, Ill., and Richland County, Ohio

Example of First Class

The Missouri Highway Department has built several hundred miles of single-track concrete on its secondary system of state roads, a case which illustrates their use on roads of the first of the above three classifications. These roads are built with the idea of conserving construction funds until such time as traffic justifies a two-lane road or until funds are available for widening. Since they are on the secondary state system and since they may reasonably be expected to care for traffic of the usual intensity found on state roads within a short time, the standards of design, such as horizontal and vertical curves, roadway width, and related matters, are equal to those used on the state primary system of roads. This same idea should be applied to the heaviest traveled roads on county systems.

Second Class Single-Track Roads

There are many miles of road on both state and county systems which fit into the second classification of use. These roads will probably carry relatively low traffic volumes for a number of years. More of these roads are being absorbed each year into state systems. If these same roads were improved with the usual low cost materials, relatively little money would be expended on such items as new location, reduction of grades, major alignment changes, first class drainage structures and widening of the roadbed. The engineer would reason that all of these could be done, if and when sufficient traffic develops to justify it. If that is so with these surfaces, it would seem just as reasonable to place a single-track concrete road on the same kind of roadbed. At least some design requirement between these standards and the maximum state standards is justified.

Third Class Roads Purely Local

Roads in the third class of use—that is, those having present low traffic and on which no appreciable increase is ever expected, present a different problem altogether. It should be remembered that these roads serve purely local and agricultural regions and no great increase in the population tributary to them can be predicted, reasonably, for many years, if ever. These roads serve traffic which learns to know the peculiarities of its own particular road in intimate detail. Their use by strangers will be very limited. Here standards of design can be lowered so that the location of the new road closely approximates the old one. Grading costs can be reduced to a minimum. New locations should be used only where the economy is clearly justified, old drainage structures can be utilized and sight distances and curve radii can be kept at a reasonable minimum. In other words, the prime factor to be considered in roads of this type is the construction of a suitable road surface which will allow the farmer to reach his town market at all seasons of the year.

Sectional Meetings New Plan of Reinforcing Institute

The eighth annual meeting of the Concrete Reinforcing Steel Institute, scheduled for March 7 to 9 at Atlanta, Georgia, was cancelled and a sectional meeting held there at that time.

Other sectional meetings are to be held during April in Philadelphia and Chicago.

Test Roads Paved With Cement and Glass

Experiments have been carried out in Czechoslovakia during the past few months with roads surfaced with glass. A compound of cement and powdered glass was used, and it is claimed that the experiments have shown this mixture to provide a durable and efficient surface.

The Workability of Concretes

Noted French Engineer Discusses Value of Various Methods for Measuring Workability—Definitions and Opinions

By RENE FERET

HAVING always fought against the introduction of strange words in the French language, I wish to avoid the reproach for having used one as the title of this communication, and to have repeated it in every phrase. My excuse is that this paper deals with a new notion still very vague, and it is, therefore, perfectly natural to designate it provisionally by the word adopted by the country where this notion is especially studied, until we are agreed as to the French terms best suited to define it.

This translation of Feret's interesting paper on workability is taken from the "Proceedings" of the French Society for Testing Materials, and is made available to readers of *Concrete* through the courtesy of the translator, R. L. Bertin, chief engineer, White Construction Co., Inc., New York.

Detailed discussions of several of the principal test methods for determining workability, and brief discussions of a number of miscellaneous methods, will appear in the concluding installment of the paper in next month's issue.—The Editors.

FIRST — DEFINITIONS AND THE VARIOUS OPINIONS

I want to speak of the aptitude of concretes whereby they lend themselves more or less easily to the work required to implace them. For several years this important question has been particularly alive in America, where several large associations, such as the A. S. T. M. and A. C. I., have devoted series of reports and discussions to this subject. From these exchanges of viewpoints, as well as a number of articles published by the technical press, it seems that up to the present one must bear in mind the following considerations:

Workability must not be confused with consistency or plasticity. These properties, in fact, bear certain more or less complex relations to the internal friction, the rigidity, the elasticity, the viscosity, the mobility, and the fluidity.

Superintendent Determines Degree of Workability

If to a given mixture of cement, sand and stone are added progressive increments of water, one obtains after mixing a series of concretes of different consistencies—the first ones dry, the next more or less plastic, and the last ones soft. In the laboratory tests conducted on concretes of a similar series, the most plastic consistency corresponds approximately to the maximum of compaction and also to the maximum of resistance. In practice, however, it is convenient generally to adopt a consistency somewhat softer. It is only beyond the plastic consistency that a cylinder of concrete left to itself slumps more or less under its own weight.

If the concrete is subjected to trepidations, it tends to spread itself and to allow the escapement around its base either of stone or water, depending upon whether the proportion of water used was too low or too high. As its name implies, workability is the property which concrete possesses whereby it can be worked easily with a minimum of force and time. Since the amount of work depends on the nature and possibilities of the job, the best workability is not the same in every case. One must recognize the distinction between the quality which consists for a concrete in not separating itself into elements of various sizes during the transportation and placing (absence of segregation), and its ability to penetrate uniformly and without effort in all the different parts of the forms which it must occupy, and its ability of being tamped or sliced easily. The appreciation of the best conditions of workability rests with the job superintendent. He must base his judgment on the nature of the work, the method of transportation of the concrete, and the relative importance of workability with reference to other factors from the standpoint of ultimate cost.

The workability of a concrete depends at the same time on the nature of the binder, the nature of the special materials, generally fine powders which are sometimes added to it, the nature of the forms, of the condition of the surface, of the maximum size, the grading of the combination of the sand and stone, of the quantity of water introduced, and of the mechanical condition of the mixer, but it is especially modified by the richness in cement; when the proportion of cement is low, the proportion of water can be increased only a slight amount, and then without much improvement. If we call C, S, P and E, the quantities of cement, sand, stone and water which enter into a concrete, its resistance is specially governed by the ratio $E:C$, its consistency by the ratio $S:P$, and its workability by the ratio $(C : E) : (S : P)$, or of the paste of cement to the aggregate.

Methods of Improving Workability

The workability can be improved; first, by increasing the proportions of cement and water in such a way that their ratio remains constant; second, in properly choosing the sand and the stone and mixing them in such a way as to realize the optimum granulometric composition;[1] third, by the addition of certain very fine materials.

Certain practitioners recommend mixing the water and the cement completely before introducing the inert materials and to prolong the mixing sufficiently.

The choice between these various means must be guided by the increase in expense resulting from each one, and compared to the resulting economies of installation, and the better guarantees of quality which result from the corresponding increased workability.

It is of primary importance to know how to define the workability of concretes, and to be able to control it practically on the works. However, inasmuch as we are dealing with a complex quality, subordinated to various local conditions, it is possible that depending upon the cases at hand, the best methods to adopt for its measurement may not always be the same.

(The concluding installment of Feret's paper will comprise a study of the principal test methods, as well as a number of miscellaneous methods, for the determination of the degree of workability of concrete. The author's conclusions will also be given.)

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[1] According to Abrams, when the proportion of cement and the maximum size of the stones or pebbles is fixed, the granulometric composition is of minor importance as long as the fineness modulus (function of the proportions of particles of various sizes) remains within certain limits.

Marking Concrete Flagstone Patterns in Walks, Drives and Floors

Method Originated by Nebraska Builders — Only Topping Course Is Divided—Mineral Colors Employed

By DOUGLAS McKNIGHT
Field Engineer, Portland Cement Association
Lincoln, Nebr.

The present-day desire for homes of distinction, for homes that express the individual taste of the owners, and for homes that harmonize with their surroundings has brought about considerable change in builders' methods throughout the country. At Kearney, Nebraska, for example, McClure and Company, designers and builders, have been specializing in custom built houses. Hugh McClure, manager of this company, has an organization that not only builds the house but also constructs the walks, drives, summer houses and garden pools which combine to make each home distinctive.

Marking Flagstone Joints

Mr. McClure has originated a method of marking flagstone patterns in walks and drives constructed of concrete. The effects he obtains are unusually artistic. These sidewalks and driveways, built to resemble flagging, add both charm and individuality.

In using this method a sidewalk or driveway base course is laid in the usual manner. As soon as the base course is in place, beveled wooden dividing strips about ¾ in. thick and 12 to 18 in. long are placed to simulate the joints between flagstones. The strips and the manner of their use are illustrated in Figure 1. Then the blocked-off areas are filled with the finish course concrete and trowelled off level with the top of the joint strips. Several shades of gray have been used or various colors incorporated in this finish concrete in order to get contrasting flagstones. After the concrete topping has hardened, the strips are removed (they are cut with a bevel narrowing toward the bottom) and the joints or scorings left are filled with mortar having some contrasting color.

The results obtained are quite pleasing, and the method is flexible. Large flags can be simulated in wide expanses of driveway and small flags in narrow walks or vestibules. The process is good structurally, because the firm base and the good bond of the color course with the

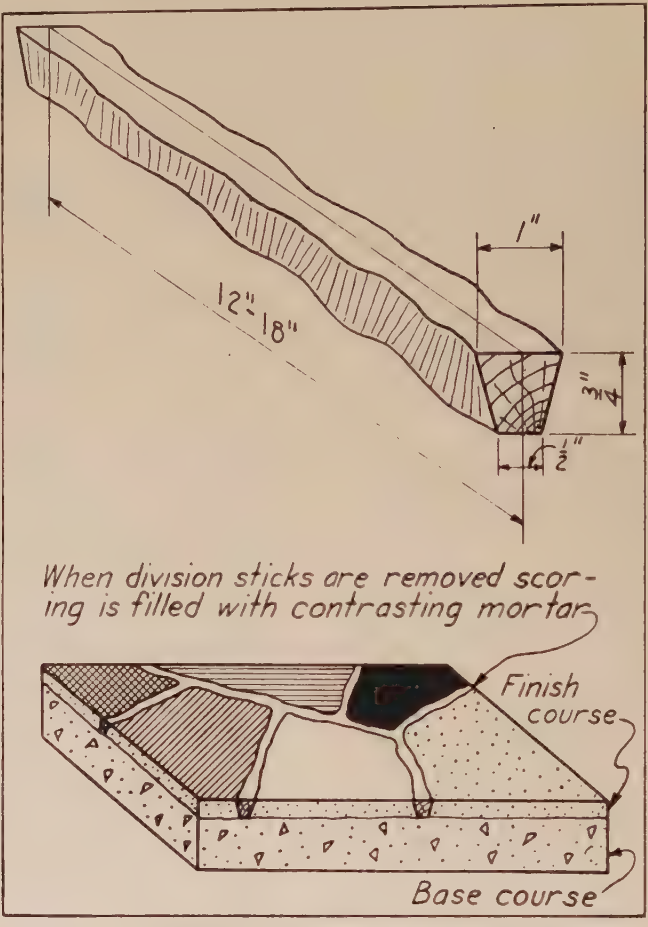

1"
12"
18"
3/4"
1/2"
When division sticks are removed scoring is filled with contrasting mortar
Finish course
Base course

Figure 1. Showing use of dividing strips. The upper sketch shows the detail, while the lower shows the method of placing dividing strips

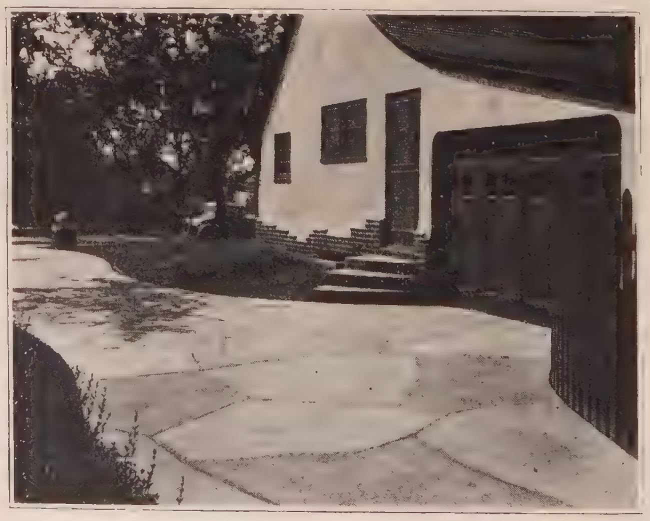


Figure 2. Private drive, with concrete flagstones in gray tints

base course prevents uneven settlement and avoids the necessity for resetting stones.

Good Effects Obtained

The effects obtained with the type of construction described may be seen in the illustrations, one of which is a view of an exterior driveway and the other is an interior floor. By the use of black mineral colors the flags were colored in various tones of light gray, and the joints were filled with black cement mortar. The rear steps shown in the outdoor picture were made very dark gray by the use of the same black mineral color. The interior view illustrates a corner of the solarium, with its colored concrete flagstone floor.

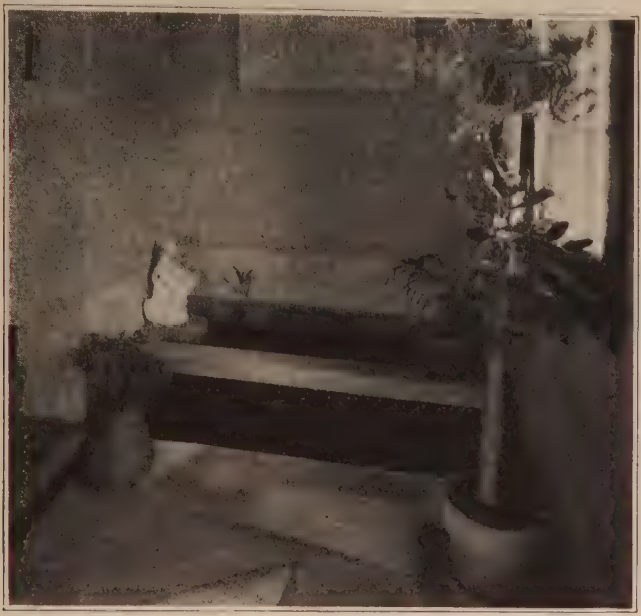


Figure 3. Colored concrete flagstones in floor of solarium

Would Utilize Machine Age to Shorten Working Hours

Benjamin Wilk Discusses Crabbs Letter on Efficiency—Illustrates Point With "Island Laboratory"

Editor, CONCRETE:

I have read with much interest the letter from Austin Crabbs, printed on page 30 of the March issue of CONCRETE, in which he comments on your December editorial, headed "Tomorrow—1932."

Mr. Crabbs has, apparently, done considerable thinking on the subject and even answered his own questions by the following statement: "The future may even disclose that one means of obtaining such a balance will be shorter hours and more men employed in a given industry."

Whenever new machines are brought into use, naturally, certain individuals are thrown out of that particular employment, but that does not mean that we should stop inventing machines. After all, the purpose of machines is to help man, and if that means cutting down the number of working hours, that is something that should be worth while. Apparently, the difficulty is due to the fact that we are in a readjustment period, and that the problem of readjusting the conditions equitably for millions of people is not a simple matter.

If we only had to make the necessary changes for one hundred people in one place the solution would not be difficult. We can readily imagine one hundred people on an island with all our present machinery for the production of food, clothing, shelter, and for the use of leisure. It is easy to see that if at one time every one of the hundred people had to work eight hours a day to obtain sufficient food, shelter, clothing and recreation, for his needs, we might very easily, by the introduction of new machines, cut down the necessary time for obtaining the same food, shelter, clothing, and recreation, to four hours, or even three hours per day.

We could look at the one hundred people and the island as a laboratory from which to develop the process that would be workable in readjusting conditions for the millions of people throughout the country.

I have confidence in the ability of the human mind to overcome difficulties. The progress that has been made from the savage to the present so-called civilized state, leads me to believe that we will continue to invent machines and that we will evolve means of balancing conditions so that the machines will be helpful rather than detrimental.

I certainly do not agree with Mr. Crabbs that we ought to "soft-pedal" efficiency. The need is to make use of the efficiency that is at present available for the benefit of mankind.

BENJAMIN WILK,
Manager, Standard Building Products Co.
Detroit, Michigan,
March 15, 1932.

$1,353,000,000 Road Program for State and Local Agencies

Funds estimated as available for public road and bridge construction and maintenance in 1932 amount to $1,353,000,000, according to information collected from road officials by the Bureau of Public Roads. Of this amount $882,000,000 is the probable expenditure by state highway departments, and $471,000,000, it is expected, will be spent by local authorities.

The detailed total of road and bridge expenditures in 1931 is not yet known but the 1932 program is less by 19 per cent than the total rural road expenditure of $1,680,000,000 in 1930. Comparing state highway expenditures of $980,000,000 in 1930 with similar funds available for 1932, there is a decrease of 10 per cent. Similarly there is a decrease of 33 per cent in local funds, the 1930 expenditure having been $700,000,000.

The total estimated expenditure of the state highway departments of $882,000,000 is divided as follows: Construction of roads and bridges, $568,000,000; reconstruction and maintenance, $197,000,000; interest on highway bonds, $64,000,000; and miscellaneous, $53,000,000.

The state highway departments plan to construct 36,000 miles of road, including 8,800 miles of high-type road.

The states with highway programs in excess of $50,000,000 are listed in order of size of program as follows: Pennsylvania, New York, Illinois, California, New Jersey, Ohio, Texas, Missouri, Michigan.

The local program of road construction will exceed $25,000,000 in the following states, which are listed in order of size of program: Pennsylvania, New York, California, Ohio, Illinois.

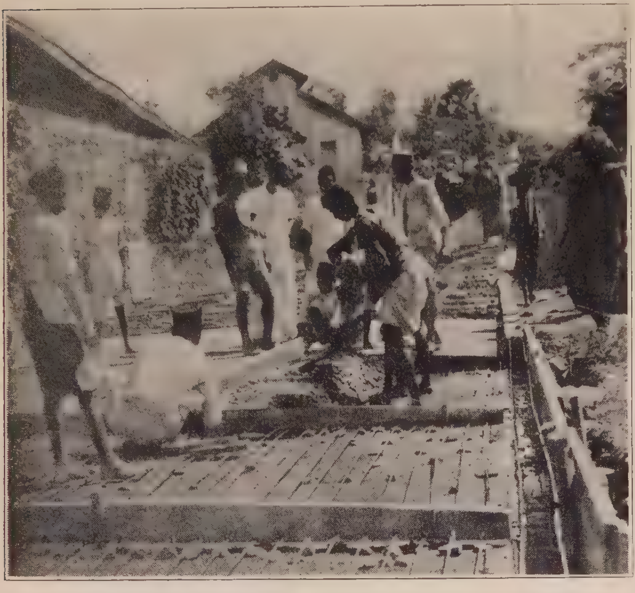
Where Labor Takes Place of Concreting Equipment

Hand Methods of Mixing and Distributing Concrete —Views of Concrete Construction in India

A correspondent in India has sent photographs of concrete highway and building construction operations taken in India late in 1930.

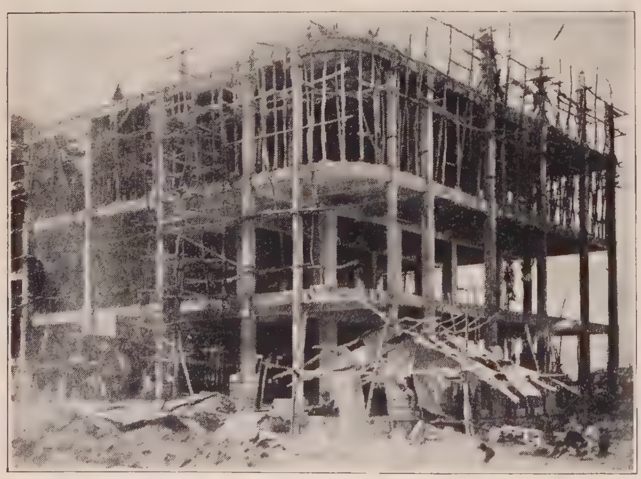
The pictures, reproduced here, illustrate the almost total absence of construction equipment on important work, in a country where native labor is cheap.

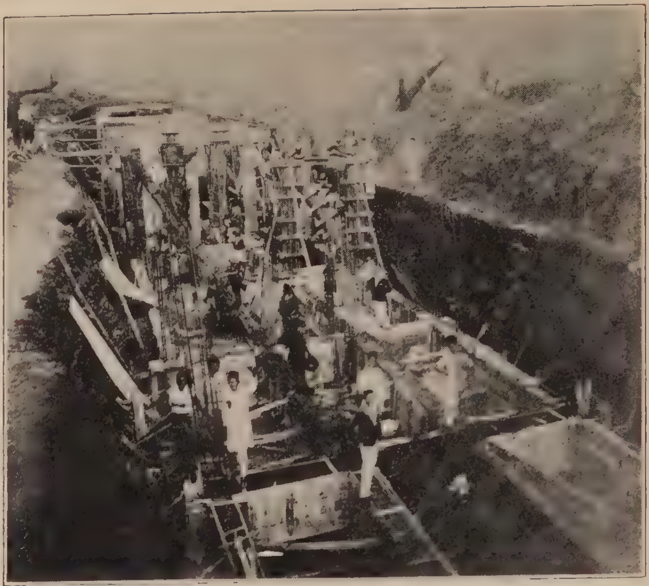
In the first illustration a concrete street is being placed by hand labor methods. The concrete is carried in small receptacles from the point of mixing to the point of deposit, by natives who carry the load on their heads.



The surface of the pavement is formed by a screed operated by hand.

Another picture shows a multiple-story reinforced concrete building under construction in Bombay. Observe the absence of a hoisting tower or other evidences of the presence of modern construction equipment. A magnifying glass discloses the presence of a mixing platform in the center of the left-hand side of the building, and a well braced ladder leading from a point near the platform to the top of the structure.





The third illustration is that of a canal being lined and covered with reinforced concrete. Here, again, the place is swarming with workmen, but construction equipment is absent.

Business Needs New Kind of Selling

By **BLAINE S. SMITH**

President, Pennsylvania-Dixie Cement Corp., New York

Post-mortems that provoke controversy, and predictions that only further inflame pessimism, will contribute nothing helpful to the present situation in business.

What business needs right now is a new kind of selling which begins with this fundamental action—that we all sell to those with whom we come in contact the idea that this country is sound, far ahead of any other nation in the world, and it is now the individual responsibility of each of us to keep it in that position.

Millions of volunteer salesmen working at that task of selling the United States of America will go far toward establishing the faith that is always necessary to any constructive effort.

Another phase of this new kind of selling, particularly in the contracting field, will be that the contractor won't wait for builders to seek him out and invite bids. He will instead seek them and take advantage of every opportunity to create demand for his services by showing that labor and materials are low, and labor very productive.

In every community, the alert observant man will see properties that could be increased in value by much more than the cost of improvements, and by indicating to the owner the benefit to be gained he will create business for himself.

Generally speaking, money spent in building has always been one of this country's soundest investments. There is no reason apparent that it will not continue to be sound, and profitable.

The new selling won't wait for the potential buyer to "want something built." It will instead find the potential buyer, and through convincing presentation create the desire by emphasizing the need to have something built. Such effort, multiplied many times, will be a vital force in making business better.

Writing a Purchase Specification for Ready-Mixed Concrete

Protect the Consumer Without Unduly Hampering the Producer—Proof of Quality Based on Actual Tests—Weighing of Materials Urged—Specifying Admixtures

By R. B. YOUNG
Consulting Engineer, Toronto, Ontario, Canada

THE natural approach to the problem of preparing a purchase specification for ready-mixed concrete is to take one of the accepted present-day specifications for job-mixed concrete and modify it to apply to the newer product. Such a procedure is sound in so far as ready-mixed concrete is subject to the same fundamental laws of physics and chemistry as all concrete, but in so doing there is the danger that the modified specification will, figuratively speaking, carry a whip socket on the dash, as did the early automobiles; hence every requirement written into the new specification should be examined critically to see whether it is or is not one that is applicable or necessary in the present case. Also, it should be remembered that the ideal specification fully protects the consumer without unnecessarily interfering with or hampering the producer, and every requirement should be examined also from this standpoint.

A concrete specification falls naturally into nine divisions:

(1) General Clauses
(2) Materials
(3) Proportions
(4) Consistency
(5) Measurement
(6) Mixing
(7) Delivery
(8) Inspection
(9) Tests and Acceptance

Under the first division come such general items as scope and limitation of the specifications, the definition of ready-mixed concrete, and any other matters of similar nature. It should not, however, include items dealing with questions such as damages arising from failure to maintain deliveries, payments and terms, and other matters that form part of the usual contract between buyers and sellers of merchandise or services.

Materials

The materials to be dealt with under this heading are cement, aggregate, water and admixtures. The first two can be disposed of briefly by references to the existing standard specifications of the American Society for Testing Materials, and water can be covered by requiring it to be fresh and free from harmful impurities.

Admixtures are not so easily handled. Most engineering and architectural specifications permit the addition of admixtures only when specifically authorized. On the other hand, many operators of central mixing plants have found that under certain circumstances an admixture helps them to deliver a better concrete. To forbid entirely the use of admixtures would hamper these particular operators, but to allow their use indiscriminately would bring the specification for ready-mixed concrete in conflict with the majority of present concrete specifications, which would seem to be unwise. The author's own view of this dilemma is that it would be best to specify that admixtures may be used with the permission or on the instructions of the buyer, leaving it to the operator who wishes to use them to convince his customer that they are beneficial.

Proportions

The quality of concrete is usually specified in one of several ways, by arbitrarily set proportions, by cement content, by water-cement ratio, by compressive strength at some given age, or by a combination of these, to which should be added a reference to the consistency of the concrete when delivered.

When arbitrarily set proportions are used as a measure of quality, the only problem which the producer has is to determine the equivalent batch quantities, and to provide for this, the specification should include a clause stating exactly what is meant by a cubic foot of cement or aggregate. The common practice is to consider that a cubic foot of cement is equivalent to one sack weighing 94 lb. net, and that a cubic foot of aggregate is equal to its unit weight when tested dry, in accordance with the standard methods of the American Society for Testing Materials.

Meeting the Specified Quality

When any of the other three methods of stating quality are used, it is left to the producer to design a mixture that, with the proper consistency, will either have the required cement content or water-cement ratio or produce concrete having the specified strength at the age set. At once there arises the question of how far the producer shall be allowed a free hand in determining the mixes that will meet the requirements for quality. All producers do not have the necessary knowledge to allow them to design concrete mixtures, but this is almost equally true of engineers and architects. There is, besides, the temptation to design the cheapest mixture that will "get by." Some safeguards should therefore be set up.

Presented at second annual convention of the National Ready-Mixed Concrete Association, Pittsburgh, Penna., Jan. 25 and 26, 1932.

When the quality of concrete is defined by its consistency and either its cement content or water-cement ratio, or both, the minimum amounts of cement and water which the producer is likely to use are established within fairly narrow limits. It is improbable that the producer will use more cement than the minimum unless it is necessary to do so to meet the consistency requirement or the combined water-cement ratio and consistency requirement. In this case the only safeguard required is to prevent the producer from using too little or too much fine aggregate. This can be prevented quite simply by a clause such as has been used in a number of specifications stating that the quantity of fine aggregates in any concrete mixture shall not be less than one-third or more than one-half the total aggregate used.

When concrete quality is specified in terms of its compressive strength at some age there are added complications. It is necessary to state just what is meant by a certain strength at a certain age, and on what basis the concrete must be designed to insure to the buyer that the specified strength will be met. There is also the question of determining what constitutes performance in meeting the requirements. This, however, will be discussed later, under "Acceptance."

The question of how the specified strength shall be defined is logically taken care of by referring to the standard methods of testing concrete that have been developed by the American Society for Testing Materials, and stating that concrete of a certain designed strength shall have a certain minimum compressive strength at a stated age when made, cured and tested in accordance with the standard methods of the American Society for Testing Materials, leaving it to the engineer or architect to determine the relation that should exist between these requirements and working stresses, durability, fire resistance, and the like.

Basing Strength on Actual Tests

Data are available by which a producer of ready-mixed concrete can design a strength concrete with reasonable assurance of meeting the requirements, but the most exact way is for him to have tests conducted on his own materials and base his designs on these tests. It seems to the author that it is hardly reasonable for a producer to ask a buyer to have confidence in his ability to meet a strength specification if he has not found out for himself what his raw materials will do. On this basis, the author would be inclined to require that designs for strength-specified concrete be based on actual tests of the producers' materials or equivalent data obtained during operation.

Building codes usually require that when concrete is designed on the basis of water-cement ratio and strength, the actual strength used in determining the proportions must be 15 per cent greater than the minimum required by the code. This requirement should be included in the specification for ready-mixed concrete, not only because it is a wise provision, but because a very considerable volume of concrete is sold subject to building code requirements.

There are many ways of determining the actual proportions necessary in any given case, by voids, water-cement ratio, mortar voids, trial and error, and so forth, and it would be difficult to include all of these in a specification without making it too long and cumbersome. It is unfortunate that these methods have not been codified by the American Society for Testing Materials or the American Concrete Institute, as such a document would not only be of considerable assistance to the average ready-mixed concrete operator, but could advantageously be referred to in such a specification as is under discussion.

No matter by what method the proportions are obtained, the batch quantities will be determined first in terms of dry aggregates and the total amount of water required. The specifications should require that before these may be used in batching, they shall be corrected as necessary for the natural moisture contained by the aggregate.

Consistency

Workability is one of the basic properties required of a concrete mixture. It is also the one of most immediate concern to the user and the one over which there is as much argument as any between user and producer. In practice, workability is referred to as consistency, and is usually measured by the slump test. So far, no better field method has been devised for this purpose than the slump test, and while it admittedly has many and serious limitations, it is sufficiently reliable and definite for the class of concrete mixtures generally used in the ready-mix industry, to be made a part of a specification. It is the author's suggestion that in the specification for ready-mixed concrete the average slump of each class of concrete should be definitely stated, that reference be made to the standard method of determining slump adopted by the American Society for Testing Materials, and that a tolerance of 1 in. above and below the average slump be allowed to take care of minor variations in the consistency of the concrete and the known inaccuracies of the test.

Measurement

The weighing of aggregates has become almost universal practice in ready-mixed concrete plants and its proved advantages make it a desirable requirement in a ready-mixed concrete specification.

While certain authorities feel that measurement of the cement by weighing is not so essential, since the sack of cement is a definite unit, the author is of the opinion that weighing of the cement should also be required. Cement should always be weighed in a separate hopper from the aggregates.

Mixing water can be accurately measured either by weight or volume, and the proper provision here would be to insist that whatever the device, its readings be accurate within ½ to 1 per cent. For truck-mixer operations, the measurement of water in the water tank mounted on the mixer should, in the author's opinion, be forbidden. Instead, the proper amount should be measured at the plant at the same time the cement and aggregates are batched and the measured water then run into the truck tank when the mixer is being loaded.

The producer of ready-mixed concrete should, for his own protection, have his plant equipped with accurate weighing devices, and the specifications should so require. It may be argued that this is a detail with which the buyer is not concerned if he gets the required volume and quality of concrete; but since the best assurance the buyer has that both of these requirements are being met is by plant inspection of the batch quantities, he is justified in insisting on the accuracy of the weighing equipment. This feature can be taken care of by specifying that all weighing equipment meet the requirements for Weighing Devices for Concrete Aggregates of the American Road Builders Association.

Mixing

Any specification for mixing must take into consideration the two different systems used by ready-mixed concrete plants, namely, mixing at the plant, and mixing in transit.

The first system differs in its requirements from the standards found necessary for job-mixed concrete, only in that the central-mixing plant usually uses mixers of much greater capacity than are found in job plants. The same safeguards that experience has found desirable for job-mixing should be required for central plant mixing, and some sliding scale of mixing time, increasing as the capacity of the mixers increase, should be included to provide for the slower mixing action of large mixers. The author would suggest a minimum requirement of a minute for mixers of one cu. yd. capacity and less, increased by one-half minute for each additional cu. yd. or less of capacity.

The truck mixer is somewhat more difficult to provide for in a specification than a stationary mixer, because it is not so well standardized, and information on the performance of different types is meagre. The drum should be watertight when closed; it should have a total volume of at least twice its wet batch capacity; and it should be driven at the proper speed. The proper mixing time is harder to specify, for it varies not only with capacity, but with different types of mixers, and the differences between them are so great that it would be difficult to set a mixing time that would be safe for all, and yet be fair to the more efficient. Some study will have to be given to this point before definite limits can be set.

(The next installment will discuss delivery, inspection, tests and acceptance of ready-mixed concrete.)

British Report on Durability of Concrete in Sea Water

A committee of the British Institution of Civil Engineers has, since 1916, been investigating the deterioration of concrete and metal structures in sea water. Since the publication of its first report in 1920 annual interim reports have appeared, the twelfth having just been published. This report consists in the main of records of deterioration observed or measured in specimens or structures exposed for periods of years. An extensive series of reinforced concrete specimens was investigated.

The examinations of the reinforced concrete specimens under test in Britain ranged over periods up to 23 months, and extended over two similar sets of short piles, one of which was exposed in sea water at Sheerness and the other in artificial sea water of three times normal strength at the Building Research Station, Watford. A large number of compression-test cylinders of mixtures used for the piles were also exposed under various conditions, with results indicating variations in resistance arising with percentage composition for concrete.

A report on the internal condition of the reinforced concrete test blocks exposed in Brisbane harbor in 1917 is given. The bottom portions of the eight blocks in this series were broken open for examination after the blocks had been exposed for 13 years between high and low water levels. The results of examination lead to the conclusion that a two-inch cover of 1:2:3 or of 3:4:5 cement concrete, made with chippings ranging up to ½-in., would be sufficient for complete preservation, provided the workmanship was first-class. Four other blocks, prepared to test the protective effect of tarring, were broken open after having been exposed similarly for five years, and indicated that coating by tar offers no permanent advantage, although in earlier inspections the tarred specimens had seemed to be the better preserved.

Concrete Pavement Slabs Employed as Riprap in Denver

In widening the streets of Denver, Colorado, large blocks of concrete are torn up at one time. The problem of disposal in a manner both economical and useful was solved by employing the slabs for riprapping levees along the Platte River, which is located inside the city limits. When the levee and slabs have settled thoroughly, the cracks will be filled with concrete, making a cheap and efficient breakwater.

Using torn-up concrete pavement slabs as riprap

Promotion of Swimming Pools as Profitable Investment

Methods of promoting swimming pools as a public construction project that actually brings in a reasonable return on the investment are explained in two folders recently issued by the Portland Cement Association, Chicago.

The first folder, "How Can We Get a Swimming Pool?", describes methods of organizing a public interest campaign to promote a pool and shows a number of pools that have recently been constructed in various parts of the country. The second, "These Towns Have Swimming Pools—So Can Yours," shows how certain communities have financed their pools and cites the plans used as examples that may be followed in other localities for organizing campaigns to obtain construction funds. These brochures will be sent free upon request to any persons interested in receiving them.

Spacing of Vertical Stirrups in Reinforced Concrete Beams

Diagram Utilizes Relation Between Stirrup Spacing and Number of Stirrups as Counted From Point of Zero Shear

By **V. A. MALMBERG**
Civil Engineer, St. Paul, Minn.

THE computation of the spacing of vertical stirrups in concrete beams can be simplified by the use of the following formula:

$$s_n = s\sqrt{\frac{N}{n}}$$

This formula states that the spacing varies inversely with the square root of the number of stirrups as counted from the point of zero shear for stirrups. In this formula s_n is the spacing at the upper end of the nth stirrup shear area (see shear diagram), but for all practical purposes it may be considered as the spacing s'_n between the nth and the $(n+1)$th stirrup; s is the stirrup spacing at the face of the support and is equal to $\frac{a_s\, f_s\, jd}{V'}$, where a_s, f_s, j, d and V' have the usual significance; N is the total number of stirrups required for the typical case shown in the shear diagram and is equal to $\frac{X}{2s}$, where X is the distance from the point of zero shear for stirrups to the face of the support; n is the number of the stirrup when counted from the point of zero shear for stirrups (from point B in the diagram) and is equal to $\frac{X_n}{2s_n}$.

To obtain the spacing of the first stirrup from the point of zero shear for stirrups, n should be taken as ½. The last stirrup will be at a distance of $s/2$ (approx.) from the face of the support.

Example Illustrates Use of Formula

The following simple example will illustrate the application of the stirrup formula given above:

Clear span = 20 ft.
Width of stem = 10 in.
Depth to steel = 20 in.
Dead load = 500 lb.
Live load = 1,500 lb.
Shear carried by concrete = 40 lb. per sq. in.
Stress in steel = 16,000 lb. per sq. in.

$$\text{Max. end shear} = 2{,}000 \times \frac{20}{2} = 20{,}000 \text{ lb.}$$

$$\text{Shear at center} = 1{,}500 \times 20/2 \times \tfrac{1}{4} = 3{,}750 \text{ lb.}$$

$$\text{Total shear taken by concrete} = \tfrac{7}{8} \times 10 \times 20 \times 40 = 7{,}000 \text{ lb.}$$

$$X = \frac{V'\,a}{V - V''} = \frac{(20{,}000 - 7{,}000)\,10}{20.000 - 3.750} = 8 \text{ ft.} = 96 \text{ in.}$$

$$s = \frac{a_s\, f_s\, jd}{V'} = \frac{0.11 \times 2 \times 16{,}000 \times \tfrac{7}{8} \times 20}{13.000} = 4.73 \text{ in.},$$

requiring ⅜-in. round U-stirrups.

$$N = \frac{X}{2s} = \frac{96}{2 \times 4.73} = 10.1, \text{ say 10 stirrups.}$$

$$s = \frac{X}{2s} = \frac{96}{2 \times 10} = 4.8 \text{ in.}$$

$$s_n = \frac{s\sqrt{N}}{\sqrt{n}} = \frac{4.8\sqrt{10}}{\sqrt{n}} = \frac{15.17}{\sqrt{n}}$$

TABLE 1

Stirrup Spacings

n	$s_n = \frac{15.17}{\sqrt{n}}$	s_n Rounded Off
½	21.5 in.	21½ in.
1	15.2	15
2	10.7	11
3	8.8	9
4	7.6	7½
5	6.8	7
6	6.2	6
7	5.7	6
8	5.4	5½
9	5.1	5
10	4.8/2 = 2.4	2½
Total	95.4 in.	96 in.

The maximum spacing according to the building code should, of course, be given consideration in every case.

The stirrup spacings in the above table do not add up to exactly 96 in. because those obtained by the formula $s_n = \frac{s\sqrt{N}}{\sqrt{n}}$ are theoretically at a vertical line dividing the shear area between any two adjacent stirrups into two equal parts, and the shear at this point is always slightly greater, and consequently the stirrup spacing is less, than the average shear which determines the exact spacing between the same two stirrups. This will be evident from an inspection of the shear diagram. The difference between the exact spacing and that obtained by the formula

TABLE 2

Value of Constants K_1 and K_2

n	K_2	K_1	ΣK_1
½	1.414	*1.414	1.414
1	1.000	1.035	2.449
2	.707	.713	3.162
3	.578	.579	3.741
4	.500	.501	4.242
5	.447	.448	4.690
6	.408	.409	5.099
7	.378	.378	5.477
8	.354	.354	5.831
9	.333	.333	6.164
10	.316	.316	6.480
11	.302	.302	6.782
12	.289	.289	7.071
13	.277	.277	7.348
14	.267	.267	7.615
15	.258	.258	7.873
16	.250	.250	8.123
17	.242	.243	8.366
18	.235	.236	8.602
19	.229	.229	8.831
20	.223	.224	9.055

---

*This value of K_1 was obtained by the use of Equation (2). When $n = ½$, then $s'_n = X_n = s\sqrt{N} \times 1.414$. For this particular case, K_1 in Equation (3) corresponds to $2\sqrt{n}$ in Equation (2). Equation (3) will not hold for values of n less than unity.

$$s_n = \frac{s\sqrt{N}}{\sqrt{n}}$$ is negligible, however, as will be shown below.

In the shear diagram the positions of the stirrups are indicated by the vertical dashed lines. Each stirrup is assumed to carry one-half of the shear between it and the adjacent stirrups, or $1/N$th of the total shear carried by the stirrups. The area between the last stirrup and the face of the support and between the first stirrup and the point of zero shear for stirrups is in each case, therefore, one-half of the area between any two adjacent stirrups. It will be seen that the stirrups are approximately at the center of gravity of the shear area covered by each.

Formula for Stirrup Spacing

By the principles of geometry and algebra we obtain the following formula for the stirrup spacing at any given point in a beam:

$$s_n = \frac{s\sqrt{N}}{\sqrt{n}} = s\sqrt{N} \times K_2 \text{ where } K_2 = \frac{1}{\sqrt{n}} \quad \text{.......(1)}$$

In a somewhat similar manner we obtain the following formula for the distance of the nth stirrup from the point of zero shear for stirrups (from point B in the shear diagram):

$$X_n = \frac{X\sqrt{n}}{\sqrt{N}} = s\sqrt{N} \times 2\sqrt{n} \quad \text{.......(2)}$$

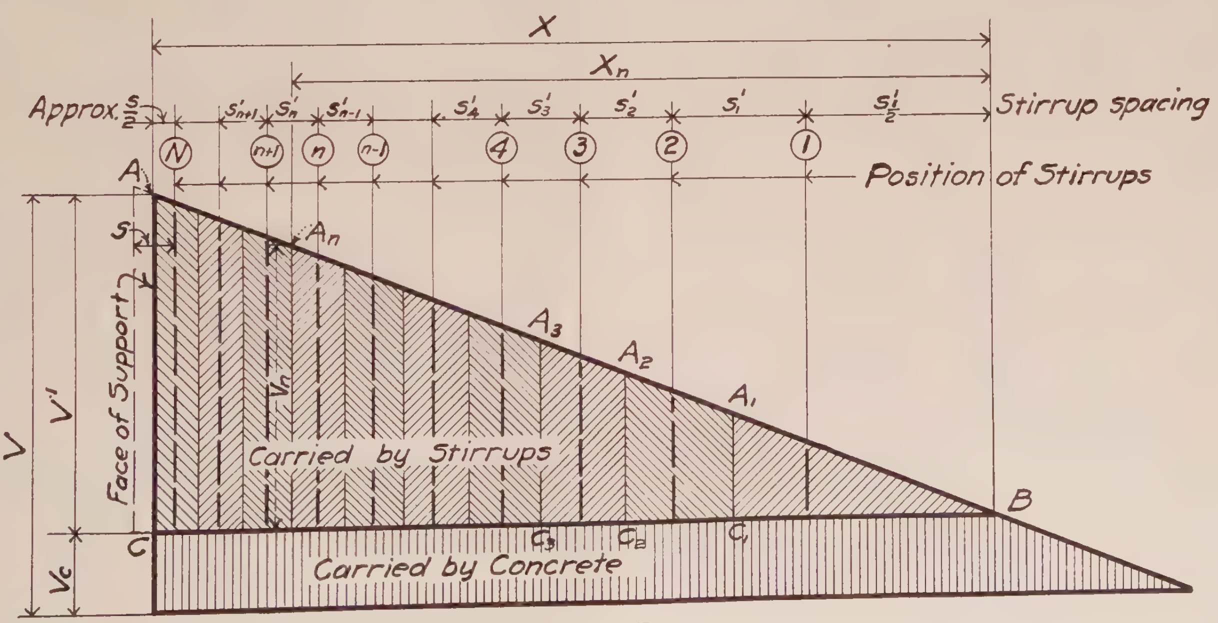
The exact distance between the nth and the $(n + 1)$th stirrup is given by the following formula:

$$s'_n = X_{n+\frac{1}{2}} - X_{n-\frac{1}{2}} = s\sqrt{N} \times K_1 \text{ where } K_1 = 2(\sqrt{n + ½} - \sqrt{-½}) \quad \text{.......(3)}$$

Equation (3) was obtained by substituting successively $n + ½$ and $n - ½$ for n in Equation (2) and then subtracting the latter of these new equations from the former.

It will be noted that the quantity $s\sqrt{N}$ is common to all three of the above equations and that it is constant in value for the typical case shown in the shear diagram.

The following table has been prepared in order to show that K_2 and K_1, and consequently s_n and s'_n, as obtained by Equations (1) and (3) respectively, are practically identical for all values of n equal to or greater than unity. This table may also be used in connection with these same equations to obtain the stirrup spacings.



SHEAR DIAGRAM

The stirrup spacing formulas given above will also hold for inclined stirrups or bent up bars used as web reinforcement. In this case the value of s to use in these formulas is equal to $\frac{a_s f_s jd}{V' \sin \theta}$, where θ is the angle between the web reinforcement and the longitudinal bars.

While the formulas given above have been worked up for the simple case shown in the shear diagram, they are, nevertheless, applicable to the more complicated cases, since the latter can be reduced to several simple ones.

Making Monuments and Mausoleums in Cast Stone

Knoxville Manufacturer Says a Few Bad Jobs Will Kill Industry in Any Community

Not infrequently CONCRETE receives inquiries from manufacturers of cast stone concerning the manufacture and marketing of concrete markers, monuments and mausoleums for cemeteries. Questions often are raised, also, in regard to the extent of opposition from cemetery officials and labor unions, or the existence of regulations prohibiting the use of concrete or cast stone for these purposes.

As a means of obtaining authentic information for manufacturers who are contemplating entry into this market, a representative of CONCRETE discussed this matter with J. W. Warren, of the Southern Cement Products Company, Knoxville, Tenn. This company operates an architectural stone plant in Sutherland Ave., Knoxville, and a roofing tile and specialty plant in Riverside Drive. At the former plant the output includes architectural cast stone, exterior and interior wall facing, mantels, ornamental garden and lawn products, and related articles.

Possibilities of Market

Mr. Warren outlined some excellent points that should be carefully weighed by manufacturers who are considering the possibilities of this market.

"So far as I know," said Mr. Warren, "there are no regulations against the use of concrete for markers, monuments and mausoleums in cemeteries; but some cemetery companies and associations do not permit the use of concrete. This attitude, of course, is prompted by bad work some time in the past.

"Success with cast stone monuments can only be expected with high-class materials and workmanship. A few bad jobs will kill the industry in any community. I have seen some very poor examples of cemetery work executed in cast stone, and from personal knowledge I know that the products were made by incompetent workmen and with the wrong kinds of material.

"We have done only a limited amount of cemetery work, for we are located in the midst of marble mills and quarries, which makes competition a little too keen to justify us in going into this market on a large scale. We have done no advertising.

"The cemetery work we have done includes one large mausoleum. For this we used our gray granite mix. It was very carefully made of coarse aggregate and was molded in sand. After it had hardened it was machine-finished. The work is standing up well and is giving entire satisfaction.

"For monuments we use coarse aggregate mixtures, molded in sand. Some of these are finished by polishing, some are axe-finished, and some are bush-hammered. Our experience has shown that a polished surface tends to show up any crazing that may occur; therefore we prefer the other finishes.

"With the use of proper materials and the exercise of knowledge and care, monuments and mausoleums can be produced that will be a lasting credit to the cast stone industry."

Other manufacturers who have had experience with cast stone cemetery work are invited to contribute their comments for the benefit of the cast stone industry.

Specifications for Admixtures to Be Prepared by Committee

Two Meetings Held in Washington Open Way for Development of Standards

A proposed specification and classification for integral waterproofing compounds, hardeners, accelerators, special cements and workability admixtures is to be undertaken by a committee representing manufacturers of these products, as a result of two meetings held during the recent annual convention of the American Concrete Institute.

This manufacturers' committee will work in close co-operation with the A. C. I. and the A. S. T. M.; but it was the general opinion that the manufacturers of admixtures should take the initiative in proposing the specifications and classifications covering their product. In accordance with this view the specifications committee was appointed.

Upon completion of the preliminary draft of the proposed standards, copies will be submitted to all manufacturers in the admixturers' association, for comment and criticism. Eventually, it is expected, a standard can be formulated that will be acceptable to the A. C. I. and the A. S. T. M., as well as to the manufacturers themselves.

R. E. Withrow, 1002 Engineers Building, Cleveland, Ohio, who represents the Medusa Portland Cement Co., is chairman of the committee that is to prepare the proposed specifications.

New International Engineering Group Meets at Early Date

The first congress of the International Association for Bridge and Structural Engineering will be held at Paris, France, from May 19 to 25.

The new organization has been formed to promote international co-operation among scientists, engineers, and manufacturers and to make possible the interchange of knowledge, ideas, and the results of research work in the sphere of bridge and constructional engineering in general. For this purpose congresses are to be held hereafter at intervals of from three to five years.

Professor Sir Thomas Hudson Beare, Edinburgh University, has been appointed by Prime Minister Ramsay MacDonald, to lead the British delegation.

HOW TO DO IT

✦ Questions and Answers ✦
Consultation and Comment

A department devoted to the solution of problems encountered in concrete work. Readers are welcome to add to or improve upon the suggestions printed and to submit their views for possible publication.

Explanation of Fineness Modulus of Concrete Aggregates

Where can I obtain an explanation of the significance of the fineness modulus as an interpretation of the grading of concrete aggregates?—S. M. I., San Bernardino, Calif.

The explanation of the significance of the fineness modulus as a measure of the grading of aggregates was originally published in 1918 under the authorship of Duff A. Abrams as Bulletin No. 1, Design of Concrete Mixtures, by the Structural Materials Research Laboratory of Lewis Institute, 1951 W. Madison Street, Chicago. The bulletin was revised in 1925.

Among other features, Bulletin No. 1 sets forth the method of calculating the fineness modulus of aggregates, the maximum permissible values of fineness modulus of aggregates, and the effect of grading of aggregates on the strength of concrete.

Very few, if any, copies of this bulletin are available for further distribution. It may be necessary to consult a copy at a technical reference library.

Specifications for Concrete Ashlar and Cast Stone Masonry

I have read, with much interest, the article on "Concrete Ashlar Masonry Opens New Architectural Field," in the March issue of CONCRETE, *and would be pleased to know where specifications for concrete ashlar masonry may be obtained.*

Kindly let me know, also, whether copies of the A. S. T. M. specifications for concrete masonry can be obtained in separate pamphlet form.—C. P. C., Lake Charles, La.

Concrete ashlar masonry units ordinarily are made as regular hollow concrete masonry building units, but in four or five different sizes. In consequence, their manufacture and use should be governed by either of the following specifications for concrete masonry building units:

(1) Specifications for Hollow Concrete Masonry Units adopted by the Federal Specifications Board and designated by the symbol SS-C-621 (see CONCRETE, October, 1931, page 20). Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 5 cents each.

(2) Tentative Specifications and Tests for Load-Bearing Concrete Masonry Units (serial designation C 90-31 T), issued by the American Society for Testing Materials, 1315 Spruce Street, Philadelphia, Penna., from whom copies may be obtained. However, the specifications section of this new tentative standard was printed in full on page 29 of the February (1932) issue of CONCRETE.

Where cast stone is used in ashlar form the product will, of course, be governed by specifications for cast stone, for which the following are suggested:

(1) Specifications for Cast Architectural Stone (SS-S-721) adopted by the Federal Specifications Board (see CONCRETE, March, 1932, page 20). Copies may be obtained at 5 cents each from the Government Printing Office, Washington, D. C.

(2) See also "Suggested Section on Cast Stone for Inclusion in Building Codes," in the February (1932) issue of CONCRETE, page 16.

(3) See also "How Architects Will Specify Cast Stone," in the September (1930) issue of CONCRETE, pages 33-34. This is the specification recommended by the Cast Stone Institute, 33 W. Grand Avenue, Chicago, Ill.

Waterproofing Concrete for a Cellar Wall

Some concrete cellar walls in our town cause considerable trouble during wet weather because of leakage. How can concrete cellar walls be made waterproof?—W. H. P., Oakesdale, Wash.

Where the wall is of new construction, use concrete which in itself is watertight. Use a mixture of about 1:2:3½, which means one sack of cement, 2 cu. ft. of sand, and 3½ cu. ft. of gravel or stone. Add from 6 to 6½ gallons of water, mix thoroughly, until the concrete has a uniform appearance. If you have a small machine mixer the mixing should continue for 1 to 1½ minutes after all the materials (including the water) are in the mixer.

Then, on the outside of the wall, trowel on a ½-in. coat of 1:3 cement-and-sand mortar.

If you have in mind an existing cellar wall in which leakage has developed, a quick setting cement-and-sand mortar can be used on the inside face of the wall after first cleaning the wall thoroughly with soap and water, and then rinsing it off with clear water.

Preparing Concrete Surface for Painting

How does concrete have to be treated before painting and decorating it?—T. J. O., Cedar Rapids, Iowa.

Before painting concrete it is necessary to remove all dirt and to neutralize the surface by brushing on a solution of zinc sulphate. The solution, 4 lb. of zinc sulphate dissolved in 1 gal. of clean water, may be applied with a paint brush, a mop or a squeegee after the concrete has become thoroughly dry. Before applying the paint the surface should be allowed to dry for at least 48 hours and then be brushed to remove the zinc sulphate crystals and dust.

New Books and Pamphlets

Common Brick Manufacturers Test Concrete Masonry Piers

Strength of Concrete Block Pilasters Under Varied Eccentric Loading. By J. R. Shank and H. D. Foster. Published as Bulletin 60 of Ohio State University Engineering Experiment Station, Columbus, Ohio, September, 1931. Paper cover, 35 pages, 6 by 9 in.; tables, diagrams and halftone illustrations. Price 50 cents, but a limited number of copies are available for free distribution.

These tests were conducted in co-operation with the Common Brick Manufacturers' Association of America, this association having provided the funds for the conduct of the work, including the cost of the cinder concrete units, the construction of the test specimens, and assistants required for making the tests.

International Congress Reports in Second Edition

Reports Presented at the First International Congress on Concrete and Reinforced Concrete. Second edition, in two volumes; 900 pages, 10 by 12½ in.; 1,200 illustrations and many plates. Published by La Technique des Travaux, 196 Rue Gretry, Liege, Belgium. Price, $10.00.

This second edition of the papers presented at the First International Congress on Concrete and Reinforced Concrete, held at Liege, in September, 1930, contains the minutes of the technical proceedings and the discussions, as well as the technical papers and general reports presented at the congress.

Design Formulas for Multiple-Span Rigid Frames

Mehrstielige Rahmen (Multiple-Span Frames). Third edition, 1932. By Dr. A. Kleinlogel. Published by Wilhelm Ernst & Sohn, Berlin, Germany. Paper cover, 288 pages, 6¾ by 9¾ in., extensively illustrated with design diagrams. Price 24.50 marks.

The rigid frames treated in this volume are the bridge type, applicable especially to the design of reinforced concrete girder bridges in which the girders are monolithic with the supporting members. Numerous cases are given, grouped into fifteen general types, formulas being given for each case illustrated, as in other technical publications by this well known author.

Lehigh University Column Tests

Tests of Reinforced Concrete Columns. By Willis A. Slater and Inge Lyse. Published by The Institute of Research, Lehigh University, Bethlehem, Pa. Paper cover, 99 pages, 6 by 9 in., numerous diagrams and halftone illustrations. Price, 50 cents.

This publication contains the first and second progress reports on the tests of full-size reinforced concrete columns being conducted at Lehigh University as a part of the program of the American Concrete Institute. It is an authorized reprint from the Journal of the A. C. I. for February and March, 1931.

Other phases of this test program are under way at the University of Illinois.

ORGANIZATIONS

American Association of State Highway Officials; W. C. Markham, Executive Secretary, 1222-24 National Press Building. Washington, D. C.

American Concrete Institute; Harvey Whipple, Secretary, 641 New Center Building, Detroit, Mich.

American Concrete Pipe Association; M. W. Loving, Secretary, 33 West Grand Ave., Chicago.

American Road Builders' Association; Chas. Upham, Engineer-Director, National Press Building, Washington, D. C.

American Society of Civil Engineers; Geo. T. Seabury, Secretary, 33 West Thirty-ninth St., New York City.

American Society for Testing Materials; C. L. Warwick, Secretary-Treasurer, 1315 Spruce St., Philadelphia, Pa.
Thirty-fifth annual meeting, June 20-24, Haddon Hall, Atlantic City, N. J.

Associated General Contractors of America; E. J. Harding, Managing Director, 222 Munsey Bldg., Washington, D. C.

Building Officials Conference of America; Col. John W. Oehmann, Secretary, 1253 Lawrence St., N. E., Washington, D. C.

Cast Stone Institute; L. A. Falco, Secretary, Chapel St. and Blatchley Ave., New Haven, Conn.

Cement Institute; Luther G. McConnell, General Manager, 11 East 44th St., New York City.

Concrete Masonry Association; Jack Franklin, Secretary, 7071 Plankinton Bldg., Milwaukee, Wis.

Concrete Reinforcing Steel Institute; M. A. Beeman, Secretary, Tribune Tower, Chicago.

Engineering Institute of Canada; 2050 Mansfield St., Montreal, Quebec.

Joint Committee on Standard Specifications for Concrete and Reinforced Concrete; F. R. McMillan, Secretary, 33 West Grand Ave., Chicago.

National Board of Fire Underwriters; W. E. Mallalieu, General Manager, 85 John St., New York City.

National Concrete Burial Vault Association; J. H. Stuart, Secretary-Treasurer, Bremen, Ohio.

National Crushed Stone Association; J. R. Boyd, Secretary, 1735 14th Street, N. W., Washington, D. C.

National Engineering Inspection Association; B. H. Witherspoon, Secretary, P. O. Box 1115, Pittsburgh, Pa.

National Fire Protection Association; Franklin H. Wentworth, Secretary, 40 Central St., Boston, Mass.

National Lime Association; Norman G. Hough, Secretary and Manager, 927 Fifteenth St., N. W., Washington, D. C.

National Ready-Mixed Concrete Association; V. P. Ahearn, Secretary, 545 Munsey Building, Washington, D. C.

National Sand and Gravel Association; V. P. Ahearn, Executive Secretary, 545 Munsey Bldg., Washington, D. C.

National Slag Association; H. J. Love, Secretary-Treasurer, 937 Leader Bldg., Cleveland, Ohio.

National Terrazzo and Mosaic Association; U. F. Durner, Secretary, 815 West St. Paul Ave., Milwaukee, Wis.

Northwest Concrete Products Association; W. P. Hews, Secretary-Treasurer, Yakima, Wash.

Portland Cement Association; Edward J. Mehren, President; William M. Kinney, General Manager, 33 West Grand Ave., Chicago.

Rail Steel Bar Association; H. P. Bigler, Engineering Secretary; Builders' Bldg., 228 N. La Salle St., Chicago, Ill.

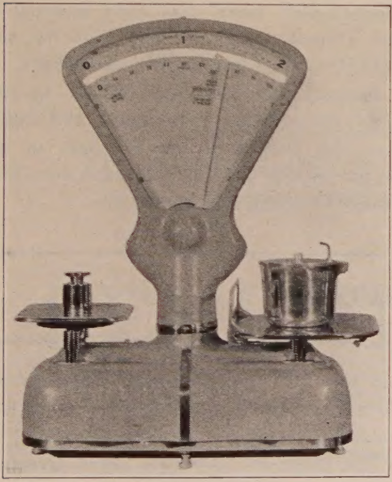
Wire Reinforcement Institute; R. D. Bradbury, Director, National Press Bldg., Washington, D. C.

Wisconsin Concrete Products Association; Jack Franklin, Secretary-Treasurer, 425 East Water St., Milwaukee, Wis.

New Equipment and Materials

Weighing With New Toledo Determination Auto-Gage

Quick and accurate determination of the specific gravity, surface moisture and sieve analysis of sand and gravel used in cement batching is said to be available with the new Toledo determination auto-gage. This scale, according to the Toledo Scale Company, Toledo, Ohio, eliminates all mental computations on the part of the operator and is simple in operation.



For the determination of specific gravity, the process is as follows: After wiping the sample bucket clean, inside and out, the bucket and its lid are placed on the scale platter, and the weight is placed on the weight platter. Surface dry but saturated sand or gravel is then poured into the bucket until the "Weight of Sand" section of the chart reads 2.67. 2.67, the average specific gravity of sand, is used to obtain in a standard sample of two pounds. The third step is to pour water into the bucket to not less than ¼ in. from the top, meanwhile stirring the sand to release air. Finally, after putting the lid on tightly and removing any water on the outside, the specific gravity will be accurately indicated on the "Specific Gravity" chart.

A similar process is followed in measuring surface moisture. The one difference is the substitution of the figure obtained for specific gravity in the first operation in place of 2.67. After filling with water, the percentage of moisture will be indicated on that portion of the chart. Otherwise the same routine is followed.

For sieve analysis, a scoop with a shoe and a scoop weight are furnished. When these are placed on the scale platters, the indicator rests at zero. Material should be poured into the scoop to obtain a reading of 100 per cent. Having obtained a sample of known weight, representing 100 per cent, the material is screened and classified. Placed in the scoop one lot at a time, the percentage of each will be indicated on the percentage graduation.

Golden Gate Tan Cement Is Launched

Golden Gate Tan cement is the new portland cement introduced on the coast by the Pacific Portland Cement Co., San Francisco, Calif.

Under the manufacturing process, a true portland cement passing the standard specifications of the A. S. T. M., is now produced for the first time in a warm, pleasing color, according to the Pacific company.

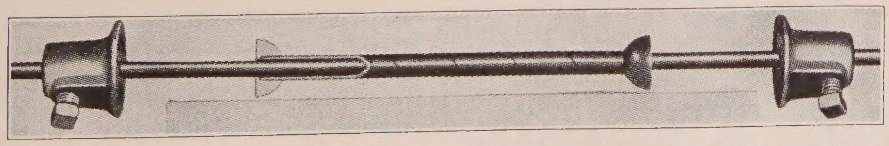
The tan, which is a permanent part of the cement, is not only a desirable color in itself, but lends itself easily to the producing of other colors with minimum amounts of pigment, it is stated.

While Golden Gate Tan cement is said to be particularly adapted to stucco because of its color as well as its plasticity and workability, its use in cast stone is also recommended.

Monolithic concrete, tennis courts, swimming pools, driveways, sidewalks and floors and walls are other uses.

New Spreader for Concrete Wall Forms

The Universal Form Clamp Co., Chicago, has developed Universal waxed paper tubing, to be slipped over the tie rod in wall forms to prevent bond between the rod and the concrete.



Universal paper tubing is made of multiple-ply straw board. Its inside diameters are such as to allow it to slip easily over a plain rod. It is supplied in 4 ft. lengths. For walls over 4 ft. in thickness, heavy paper sleeves 6 in. long are fitted over the adjoining ends of the tubing.

Buffalo Forge Bending Roll for Reinforcing Bars

A bending roll, designed for the bending of 1¼-in. corrugated reinforcing bars, has recently been developed by the Buffalo Forge Co., Buffalo, N. Y.

Material up to 1½-in. is formed at the rate of 70 ft. per minute with a 5-h.p. motor or 7½-h.p. gasoline engine, it is stated. In addition, on most types of work, only one operator is said to be required. The diameter range of this machine varies from 20 in. up.

The main frame of the machine consists of armor plate and is entirely electrically welded. The two corrugated rolls are driven while the third or adjustable roll is an idler, and adjustment is obtained by means of a screw, after which the idler roll is locked in place by means of a handwheel. A graduated scale guides the operator in setting the roll.

The machine is lubricated by means of the Alemite pressure system.

Engine Primer Is New Product of Linde Co.

The P-O-L Primer, a device for facilitating the starting of gasoline engines, either automobile or stationary, has just been introduced by the Linde Air Products Co., New York City. The Primer is a simple and easily installed device for introducing acetylene into the cylinders of an internal combustion engine, according to the manufacturer.

It consists, essentially, of a special stem type brass primer valve, a Prest-O-Lite pressure regulator and 10 ft. of ¼-in. brass tubing with compression unions.

It may be used on stationary engines and engines operating pumps and air compressors.

Fairfield Adds Sectional Belt Conveyors to Present Line

The Fairfield Engineering Company, Marion, Ohio, has recently increased its line to include sectional belt conveyors.

These conveyors are built of standardized units. Standard head and foot and sections, of the proper size to provide for ultimate conveyor length, together with the required intermediate sections for initial use are originally provided. Additional intermediate sections can then be added as desired.

Steel frames are usually furnished. However, if the purchaser prefers to furnish timber frames, complete sets of parts may be purchased.

The steel frame sections as furnished by Fairfield are of the Warren truss type welded throughout. The various units are joined together by means of heavy sleeve bolts. The returning belt is protected by a sloping steel cover. The conveyor frames are designed for unusually long spans, to avoid the need of frequent supporting structures. They can be provided with or without walkways, as desired.

Fairfield sectional belt conveyors are built with belts 18 or 24 in. in width. Maximum capacities under ideal conditions, for material weighing 100 lbs. per cu. ft., for the two sizes, are as follows: 18-in. belts—160 tons per hour; 24-in. belts—290 tons per hour.

Fairfield ball bearing idlers are used throughout in these conveyor sections. They are driven by either electric motor or gasoline engine.

About Makers of Equipment and Materials

Industrial Literature

Butler Bin Bulletins

Information helpful to road contractors and construction engineers is contained in two new bulletins just issued by the *Butler Bin Co.*, of Waukesha, Wis.

The larger of these bulletins, a 12-page booklet, covers the use of bulk cement in a broad general way. It describes and pictures the latest developments in complete bulk cement handling plants. The use of bulk cement in central mixing plants of a semi-permanent nature is also described.

A 4-page, supplementary bulletin describes in detail a new semi-automatic bulk cement weighing hopper to meet the specifications of certain state highway departments for a weighing device which eliminates the "human element" in the weighing of bulk cement. It is known as the Electro-Interlocked bulk cement weighing hopper.

Either or both of these bulletins are available to contractors for the asking.

Rex Ready-Mix Equipment

Rex Moto-Mixers and *Agitators* for 1932 are cataloged in a new, attractive publication 11½ in. wide by 8½ high, published by the *Chain Belt Co.*, Milwaukee, Wis.

Contents are arranged to show how Rex equipment meets the needs of the three different kinds of ready-mix plants. The equipment shown includes Moto-mixers, truck mixers and agitators, plant mixers, aggregate elevators, bulk cement unloaders, and belt conveyors.

Douglas Fir Plywood Facts

An A. I. A. folder, *Facts About Douglas Fir Plywood*, has been issued by *Douglas Fir Plywood Manufacturers*, Seattle, Wash.

The use of Douglas plywood for concrete form work is shown in a number of illustrations emphasizing the smooth surface secured. Other features described are its suitability for reverse molds, and non-bulging and non-leaking properties.

Pottsco Characteristics

A general presentation of the salient characteristics and advantages of Pottsco light-weight aggregate and an outline of policies of marketing and distribution is made in an 8-page leaflet prepared by the *H. H. Potts Corporation*, Chicago.

Illustrations include those showing the magnification of a granule, the aggregate, units, and installations.

Universal Atlas Dealer

Universal Atlas Dealer for February contains a number of brief articles of interest. Its cover bears a view of the Museum of Science and Industry, Chicago, in whose reconstruction Universal and Atlas White was used.

The Universal Atlas Cement Co., Chicago, distributes the publication.

Zeiss-Dywidag Construction

The *Zeiss-Dywidag* system of reinforced concrete construction of "shell domes" and "barrel shell roofs" has been licensed in the United States to the *Roberts and Schaefer Co.*, Chicago, Ill., exclusively.

Bulletin 138 has been issued by the latter for engineers, architects and builders. An outline of the principle in the design of the type of structure to which its use is adapted is given.

FIELD ACTIVITIES

Barnes Joins Butler Distributor

D. D. Barnes has joined the *H. O. Penn Machine Co.*, New York City representatives of the *Butler Bin Co.*, Waukesha, Wis.

Mr. Barnes was formerly sales manager for the Smith Engineering Works, Milwaukee.

Chain Belt Co. Distributors

The Chain Belt Co., Milwaukee, Wis., has appointed two new distributors to handle the complete line of Rex contractors' equipment. They are the *Holmes-Talcott Co.*, East Hartford, Conn., to cover Connecticut and a few counties of Massachusetts, and the *T. D. Harter Co.*, 205 N. Townsend St., Syracuse, N. Y.

The Colon-Jopson Company has also been selected as the exclusive distributor of Rex Moto-Mixers in the Hartford territory.

Earth Products Co. Organized

The Earth Products Co. has been organized at Houston, Texas, for the mining, processing and marketing of nonmetallic minerals.

A block of land in the industrial section of that city, convenient to the Ship Channel and with ample railroad facilities has been purchased. Plans and specifications for a building have been completed.

The plant will comprise three divisions, including one for the preparation of stucco, plaster, refractories, natural color sand and aggregates, and other similar products, another for the preparation of bleaching earths, and a third to be known as the custom-grinding division for the processing of materials and grinding of nonmetallic commodities to customer's specifications.

New Medusa Selling Company

Medusa Products Co. has been organized as a subsidiary of the *Medusa Portland Cement Co.* and will function as the selling company for Medusa portland cement paint; Medusa floor coating and primer; as well as the entire line of rust-proof coatings and technical paints manufactured by the *Studebaker Chemical Co.* of Elyria, Ohio, for which it will be the exclusive distributor. These products include Rust-Oy, Aluminoy, A. W. A. Paint, and a non-penetrating wall size for fresh plaster.

The executive and general offices of the Medusa Products Co. will be located at 1002 Engineers Building, Cleveland, Ohio.